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Missouri River Basin Investigations

LAND PLANNING AND CLASSIFICATION REPORT
as Relates to the Public Domain Lands
in the

POWDER RIVER BASIN
(Montana and Wyoming)

(For Administrative Use Only)

March, 1949

This report was compiled in connection with the program
of the Department of the Interior for the development
of the resources of the Missouri River Basin.

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UNITED STATES
DEPARTMENT OF THE INTERIOR

BUREAU OF LAND MANAGEMENT

MISSOURI RIVER BASIN INVESTIGATIONS

LAND PLANNING AND CLASSIFICATION REPORT
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POWDER RIVER BASIN
Montana and Wyoming

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ACKNOWLEDGEMENTS

The preparation of this report entailed the gathering of factual data from many sources including published reports and documents, the principal ones of which are cited in the appendix of this report.

Other no less important sources of information include: records of land status obtained from the Bureau of Land Management, the U. S. Forest Service, Production and Marketing Administration and from official county records for all the various counties included in this report; land-use development and conservation program reports, maps and records of the Production and Marketing Administration, and the Soil Conservation Service, especially as they involve Campbell, Johnson, Natrona and Sheridan Counties, Wyoming and Custer and Powder River Counties, Montana; land-use and tenure problems from the records of the County Extension Agents in Campbell, Johnson, Natrona and Sheridan Counties, Wyoming, and from the records of the Soil Conservation Service in Johnson and Sheridan Counties, Wyoming; published and unpublished reports, manuscripts and records and preliminary findings regarding existing and proposed irrigation developments from the U. S. Bureau of Reclamation, Fish and Wildlife Service, Geologic Survey, Forest Service, Soil Conservation Service, Bureau of Agricultural Economics, and the Montana and Wyoming State Extension Services; and other pertinent and related subject matter from the yet-clear memory of many local long-time residents of the area as well as interviews with various Federal, state and county officials.

Special mention should be made of the assistance rendered by the Production and Marketing Administration office and the County Extension Agents of Campbell, Johnson and Natrona Counties, Wyoming, and by the Range Manager, Montana Grazing District No. 3, in furnishing data on land resources, uses and problems as they relate to the public domain.

Field reconnaissance work, the assembly and analysis of pertinent information and the preparation of the report was conducted by Harold T. Tysk, Land Economist. The map was prepared under the supervision of William C. Anderson, Engineering Draftsman. The study in all its aspects was under the direction of R. D. Nielson, Land Economist in Charge of Missouri Basin Studies, Bureau of Land Management, Region III, Billings, Montana.

PURPOSE AND SCOPE

This report presents a preliminary analysis of the physical and economic features of the area in Montana and Wyoming within the drainage system of the Powder River. It is intended to serve as a guide in carrying out detailed studies of problems pertaining to the use and management of the remaining 1,800,000 acres of unappropriated, unreserved public domain lands in this area in furtherance of the total Missouri River Basin Development Program.

In carrying on the preliminary investigation and in presenting the information in this report, our primary concern and interest has been to develop factual data relating to the utilization management and development of the "public domain" lands and the resources thereon. Some study of the over-all land use economy was necessary to ascertain the interrelationships between the public land and other resources. In this connection, a general analysis of all land management programs operating in this area was made.

Particular emphasis was given to the appraisal of problems such as soil erosion and sedimentation and maladjustments in public land use. Problem areas requiring further investigation were delineated, and a more complete and detailed survey and report for such areas will immediately follow this preliminary study.

SUMMARY

"Powder River! A mile wide and an inch deep!" How often that colorful phrase has brought to mind the unique glamour of the cattle country -- the open range. "Too thick to drink and too thin to plow!" Another picturesque Powder River phrase, somewhat distorted perhaps, but one that nevertheless peculiarly focuses attention to the compelling problems to be faced by the public land administrator, who is charged among other things with the responsibility of maintaining optimum watershed conditions on the public lands in this basin. Nearly one-fourth of the total land area in the Powder River basin is administered by the Bureau of Land Management. Probably the biggest problem inherent in these lands is watershed deterioration and a resultant increase in run-off, siltation and sedimentation. While not peculiar to the public lands only, the consequences of continued impairment of these resources will adversely affect human welfare and economy throughout the basin.

Comprising a drainage area of 13,193 square miles, Powder River is an interstate stream which drains portions of central and northeastern Wyoming and southeastern Montana. Seventy percent of the watershed is located in Wyoming and about sixty percent, or 7,880 square miles, lies tributary to the site of the proposed Moorhead reservoir. The damsite is located in Montana just north of the Wyoming-Montana state line and was authorized by Congress in 1947, primarily as a silt and flood control project. It will also afford storage capacity for the irrigation of about 43,000 acres of land in Montana.

The climate in the Powder River basin is that characteristic of the Northern Great Plains, semi-arid and continental, with extreme variations and fluctuations in temperature and precipitation which in turn contribute greatly to the relative abundance or depletion of native vegetation. The vicissitudes of climate also play an important part in the methods employed in livestock and farming operations. Severe winter and spring storms, for example, present a constant threat to the stability of sheep operations.

Physiographic features are sharply contrasting. Half of the area is comprised of sharply rolling plains, another quarter is gently rolling plains, while the Big Horn Mountains and their flanking foothills make up the remainder of the basin. Elevations range from 2,250 feet above sea level at the confluence of the Powder and Yellowstone Rivers in Montana to 13,165 feet at the summit of Cloud Peak in Wyoming. The rugged Big Horn Mountains are the outstanding physiographic feature. Powder River "breaks", the badlands flanking the main river, is another important feature of the landscape. Powder River and its principal tributaries receive most of their water from the Big Horn Range, Very little perennial run-off is yielded by the low altitude plains area,

Most of the soils in the basin are shallow, heavy soils derived mainly from shale formations, although they differ materially in various parts of the area and present a wide variation in their development.

Native vegetation occupies about 96 percent of the total watershed, while the remaining area comprises crop and hay lands, water surfaces, roads and waste lands. Range lands are primarily of four types, timber, open mountain parks, sagebrush grass and grasslands, the latter type being the most extensive.

About two-thirds of the basin is in private ownership, while the remainder is in Federal or state ownership. A total of 1,830,953 acres, or 22 percent of all lands in the basin, are under the custody of the Bureau of Land Management. The greatest concentrations of such public domain lands occur in the southern portion of the basin in Wyoming, where they dominate all other classes of land ownership. While a similar pattern persists in the breaks of the Powder River, the public domain becomes progressively more widely scattered as the mouth of the river is approached.

The production of range beef cattle and sheep is the predominating enterprise in the basin. Calculated on the basis that five sheep are equivalent to one horse or cow, cattle comprise 65 percent, sheep 30 percent and horses 5 percent of the livestock population in the basin.

Crop and hay production by irrigation is an important feature of the agricultural economy. About 100,000 acres are under irrigation, while approximately 154,000 acres are dry farmed. The development of additional irrigated lands will help to balance and integrate crop and range use in areas where range livestock production is almost wholly pastoral.

Powder River basin presents a picture of diverse Federal and state land management programs including two National Forests, two Taylor Grazing Districts, one Public Domain administrative program, six Soil Conservation Districts, two State land leasing programs, two State Cooperative Grazing Districts, three Land Utilization Project Areas, one Naval Petroleum Reserve, one county park and eleven Production and Marketing Administration Agricultural Conservation programs and eleven county extension programs. Doubtless there are others.

The problems relating to the management, protection, development and utilization of the public domain lands and their resources are broadly described in the following categories:

(1) Watershed impairment and consequent siltation of stream courses and impoundments.
(2) Maladjustments in land use.
(3) Complexity of land ownership and operating patterns.
(4) Abuses on the public stock driveways and resulting soil and forage depletion.
(5) Ineffectual integration of land uses.
(6) Rodent and insect infestations.
(7) Poisonous plants.

The present study has not been of sufficient detail to determine the scope and seriousness of these problems, nor to prescribe detailed corrective measures. Further studies are necessary to obtain the basic data necessary to the solution of these and other problems which will appear as the study progresses.

Four problem areas will be studied in detail and in the following sequence:

(1) Upper Powder River, Wyoming, which will include the drainages of North, Middle and South Forks of Powder River and Salt Creek.
(2) Powder River breaks, Wyoming and Montana, which will include the main stem of Powder River tributary to the proposed Moorhead reservoir.
(3) Moorhead-Powderville area, Montana.
(4) The remainder of the basin, Montana and Wyoming, which will include those areas in the basin which contain relatively little public domain and what remains consists of small isolated tracts of land.

GENERAL DESCRIPTION

Location and Size

Powder River, a tributary of Yellowstone River, is an interstate stream draining portions of northeastern Wyoming and southeastern Montana. The basin drains an area of 13,193 square miles, equivalent to 19 percent of the entire area of Yellowstone River basin. The length of its basin in a north and south direction is about 275 miles and the maximum width is about 100 miles. The average east-west width of the basin in Wyoming is 53 miles, decreasing progressively northward to an average width of 38 miles in Montana. (See map appendix.)

The basin has its headwaters in almost the exact geographical center of the state of Wyoming from whence it flows in a generally northeasterly direction through northeastern Wyoming and southeastern Montana to its confluence with the Yellowstone River. The Powder River basin is bounded on the east by O'Fallon Creek, Little Missouri, Belle Fourche and Cheyenne River watersheds, on the south by the North Platte River basin and on the west by the Wind River, Big Horn, Tongue and Yellowstone River watersheds.

The Moorhead dam was authorized by Congress in 1947 as a flood control project and is located in Montana about three miles north of the Wyoming-Montana state line. According to plans of the Bureau of Reclamation, the dam will be of earth and rock construction and have an estimated storage capacity of 700,000 acre-feet. Its primary purpose is for flood and silt control. The dam will also afford storage capacity for the irrigation of an estimated 43,000 acres, adjacent to the Powder River in Montana. Table 1 shows by states, counties and by watershed units embraced above and below the proposed Moorhead Reservoir, the gross area contained within Powder River basin.

About sixty percent of the entire watershed lies tributary to the proposed Moorhead Reservoir and almost completely within Wyoming, less than one-half of one percent of the watershed being in Powder River County, Montana. This portion of the watershed, roughly oval in shape, contains 7,880 square miles, with maximum dimensions of about 155 miles north and south and about 60 miles east and west. The area embraces nearly one-twelfth the land area of Wyoming, including 97 percent of Johnson County, 33 percent of Natrona County, 29 percent of Campbell County, 21 percent of Sheridan County, 5 percent of Washakie County and less than 1 percent of Crook and Converse Counties.

Forty percent of Powder River basin lies below the site of the proposed Moorhead dam, three-quarters of which is in Montana, with the balance in the Little Powder River watershed in Campbell and Crook Counties, Wyoming. This portion of the watershed, roughly dagger-like in shape, contains 5,313 square miles, with maximum dimensions of 170 miles north and south and 55 miles east and west. It embraces less than three percent of the land area of Montana and one percent of that of Wyoming, and includes 61 percent of Powder River County, 34 percent of Custer, 16 percent of Carter and 4 percent of Prairie County in Montana. In Wyoming, 29 percent of Campbell County and about one percent of Crook County are embraced by the Little Powder River watershed.

Table 1 - Area of Powder River Basin
by Counties and Watershed Units (1)
Montana and Wyoming

Name of County	Area Entire Watershed		Area Below Moorhead Res. Site		Area Above Moorhead Res. Site	
	Acres	Percent	Acres	Percent	Acres	Percent
WYOMING						
Campbell	1,757,060	20.8	872,060	10.3	885,000	10.5
Converse	3,600	0.1			3,600	0.1
Crook	12,860	0.2	12,860	0.2		
Johnson	2,597,760	30.8			2,597,760	30.8
Natrona	1,141,190	13.5			1,141,190	13.5
Sheridan	332,020	3.9			332,020	3.9
Washakie	46,010	0.5			46,010	0.5
Total	5,890,500	69.8	884,920	10.5	5,005,580	59.3
MONTANA						
Carter	347,898	4.1	347,898	4.1		
Custer	805,749	9.5	805,749	9.5		
Powder River	1,333,857	15.8	1,296,005	15.4	37,852	0.4
Prairie	65,261	0.8	65,261	0.8		
Total	2,552,765	30.2	2,514,913	29.8	37,852	0.4
Entire Watershed	8,443,265	100.0	3,399,833	40.3	5,043,432	59.7

(1) Figures computed from county and state maps prepared by various agencies.

Climate

The climate of the Powder River Basin is typically semi-arid and continental with wide variations in the occurrence, duration, intensity and distribution of rainfall and with wide ranges in extreme temperatures, all characteristic of the Northern Great Plains. Maximum summer temperatures in excess of 110 degrees are experienced in the plains where seasonal variations are much greater than in the mountains. Minimum temperatures of -54 degrees have been recorded. With the exception of the mountainous area at the higher elevations, comprising approximately 25 percent of the basin, the growing season is of sufficient length, about 120 days, to mature the majority of general farm crops. Along the mountain front of the Big Horn Range, the growing season progressively decreases as elevations increase until in the higher elevations of the mountains, the growing season is often less than 60 days with killing frosts reported during every month of the year. (See Table 3.)

Yearly precipitation ranges from less than twelve inches in the vicinity of Kaycee and Sussex, Wyoming, to more than 25 inches in the nearby mountains of the Big Horns. It is this mountainous zone that provides the water for the irrigation of lands in the lower plains. Snow accounts for a considerable part of the total precipitation in this humid mountain belt and in the highest

reaches surrounding Cloud Peak are found limited areas of perennial snow fields. Runoff from the melting snow takes place principally during May, June and early July, at which time the mountain streams flow at maximum sustained rates. More than 70 lakes in the Big Horn National Forest are replenished principally by snow, and these lakes in turn feed a large number of springs, streams and wells. This zone is virtually snowbound from November to May, and inhabitants migrate to lower elevations each year.

During exceptionally severe winters, large areas of winter range in the lower elevations become practically cut off from the outside world and natural forage becomes inaccessible to livestock. When ranges are closed for either brief or extended periods, supplementary feeding becomes necessary. Feed shortages develop quite often and livestock loss and shrinkage may become severe when ranges are closed to grazing for extended periods. In the dry farming areas, such heavy snows are ordinarily very beneficial to winter and spring wheat crops.

Heavy unseasonable snows in June accompanied by cool damp weather are not uncommon. Heavy livestock losses are experienced during such storms, especially by newly shorn sheep and young lambs, Hail storms are not uncommon in some of the dry-farming areas, and they are of sufficient intensity to cause severe damage about one year in five.

Surface evaporation records during the growing season are meager. At Sheridan, the nearest station at which evaporation from a free water surface is recorded and considered as representative of conditions in the upland plains area of Powder River basin, the total evaporation averages 25.64 inches for the period April through September.

Prevailing wind direction is from the southwest. The wind is usually of low velocity which lengthens the period of surface runoff in higher elevations where drifting snow forms temporary snowfields. As a rule, strong winds are uncommon and seldom reach damaging proportions. However, when associated with winter storms, drifting snow causes considerable difficulty in both transportation and livestock movements.

The annual and growing season precipitation, together with monthly averages for the period covered, are shown in Table 2 for weather stations in or near the Powder River drainage area. The months of April, May, June, July, August and September included in the above table are shown as seasonal precipitation. Too much emphasis should not be placed upon the total precipitation because many factors such as seasonal distribution, character of precipitation, temperature and wind velocity have a very great effect upon the net benefit to growing crops. For the selected weather stations shown in Table II, seasonal precipitation averages 75 percent of mean annual precipitation for Montana stations and 69 percent for the indicated Wyoming weather stations. The range in seasonal precipitation throughout the basin varies from less than 8 inches to greater than 14 inches. Most of the areas where dry-farming presists receive from 10 to 12 inches of moisture during the growing season.

Table 2 - Average Annual Precipitation and its Seasonal Distribution (inches) (1) Powder River Basin

Location	Length of Record Years	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual	Seasonal Apr. thru Sept.
MONTANA:															
Ekalaka*	37	0.38	0.32	0.62	1.04	2.29	2.81	1.78	1.32	1.18	0.78	0.34	0.31	13.17	10.42
Knowlton (near)	15	0.63	0.58	0.69	1.42	2.18	2.96	2.39	1.09	1.09	0.98	0.71	1.04	15.76	11.13
Miles City*	40	0.64	0.46	0.83	0.97	1.89	2.42	1.67	1.20	1.07	0.83	0.55	0.63	13.16	9.22
Broadus	11	0.50	0.41	0.72	1.53	2.64	3.72	1.78	1.04	1.15	0.89	0.76	0.48	15.62	11.86
Biddle	20	0.46	0.35	0.50	1.23	2.46	2.98	2.10	1.59	1.50	1.03	0.56	0.35	15.11	11.86
Fallon*	12	0.33	0.21	0.28	0.43	2.54	3.36	1.97	1.56	1.22	0.95	0.30	0.21	13.36	11.08
Ashland (near)	11	0.68	0.53	1.19	1.65	2.09	2.18	1.57	1.05	1.10	1.20	0.73	0.54	14.51	9.64
WYOMING:															
Echeta	21	0.91	0.71	1.02	1.80	2.29	2.14	1.84	1.09	1.46	1.26	0.96	0.90	16.38	10.62
Gillette*	28	0.68	0.44	1.00	1.73	2.33	2.21	1.72	1.21	1.21	0.93	0.61	0.71	14.78	10.41
Rocky Point*	28	0.91	0.75	1.23	1.71	2.63	2.72	2.10	1.24	1.52	1.27	0.81	0.72	17.61	11.92
Ross*	13	0.35	0.46	0.75	1.35	1.97	1.91	1.26	1.01	0.93	0.92	0.55	0.39	11.85	8.43
Barnum	25	0.39	0.31	0.77	1.48	2.24	1.25	1.31	0.75	0.93	1.08	0.49	0.47	11.47	7.96
Buffalo	32	0.48	0.46	0.86	1.60	2.43	1.89	1.28	1.04	1.23	0.78	0.48	0.54	13.07	9.47
Hunter's*Station	30	0.72	0.64	1.50	2.39	3.10	2.42	1.95	1.57	1.54	1.50	0.62	0.58	18.53	12.97
9-Mile Creek	16	0.28	0.30	0.75	1.75	2.13	1.84	1.06	1.05	1.19	0.77	0.53	0.45	12.10	9.02
Casper*	29	0.60	0.71	1.15	2.06	2.20	1.38	1.20	0.93	1.15	1.25	0.79	0.73	14.15	8.92
Ervay	31	0.46	0.65	1.13	2.16	2.91	1.66	1.60	1.21	1.57	1.70	0.77	0.69	16.51	11.11
Salt Creek*	17	0.54	0.50	1.14	1.81	2.26	1.64	1.50	0.94	1.15	1.10	0.63	0.56	13.77	9.30
Sheridan	44	0.52	0.50	1.11	2.31	2.65	2.50	0.97	0.74	1.45	1.33	0.80	0.52	15.40	10.59

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(1) From U. S. Weather Bureau Record.

* Stations located outside of but near Powder River watershed.

Table 3 – Climatological Data (1)
Powder River Basin

Location	Length of Record Years	Temperatures Degrees Fahrenheit				Length of Record Years	Average Dates Killing Frosts		Average Growing Season Days	Elevation Feet
		Jan. Avg.	July Avg.	Maximum	Minimum		Last in Spring	First in Fall		
MONTANA:										
Ekalaka*	37	19.0	71.2	108	-43	37	May 19	Sept. 23	127	3,427
Knowlton (near)	14	16.4	71.6	108	-46	15	May 15	Sept. 22	130	
Miles City*	40	14.5	72.9	111	-49	40	April 30	Oct. 5	158	2,351
Biddle	19	19.4	70.4	110	-41	22	May 23	Sept. 21	121	
Broadus	11	20.3	71.8	- -	- -	---	- - -	- - - -	- -	3,026
Fallon*	12	9.6	70.4	108	-54	12	May 19	Sept. 18	122	
Ashland (near)	11	21.1	70.5	108	-43	12	May 9	Sept. 28	142	3,900
WYOMING:										
Echeta	12	20.6	70.0	106	-45	17	May 20	Sept. 15	108	
Gillette*	27	21.4	71.1	110	-40	26	May 14	Sept. 30	139	4,542
Ross*	14	20.0	69.9	102	-40	14	May 15	Sept. 22	130	
Barnum	17	21.9	68.8	108	-45	19	May 25	Sept. 19	117	
Buffalo	32	21.8	68.6	106	-40	30	May 23	Sept. 17	117	5.240
Hunter's Station*	28	18.6	58.0	99	-42	32	July 5	Aug. 25	51	7,400
Nine-Mile Creek	10	21.2	71.0	103	-43	14	May 25	Sept. 20	118	
Casper*	28	26.4	72.1	109	-41	28	May 19	Sept. 29	133	5,134
Ervay	29	20.6	66.0	100	-38	30	June 1	Sept. 14	105	
Salt Creek*	16	22.7	71.4	106	-41	16	May 11	Sept. 26	138	4,850
Sheridan*	38	19.4	68.9	106	-45	36	May 15	Sept. 22	130	3,800

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(1) From U. S. Weather Bureau Record.

* Stations located outside of but near Powder River watershed.

Physiography

The basin forms a part of two well-marked physiographic regions, the Big Horn Mountains and the Great Plains, which have sharply contrasting surface features, although minor details of relief in many cases determine the utilization of the land. Topographically, the area is most varied. About 10 percent of the area is mountainous, 15 percent foothills, 50 percent sharply rolling plains, and 25 percent gently rolling plains. The minimum elevation is approximately 2,250 feet at the confluence of the Powder River and Yellowstone River in Montana, and the maximum is 13,165 feet at the summit of Cloud Peak in the Big Horn Mountains in northwestern Johnson County, Wyoming. About three-quarters of the basin lies at elevations below 5,000 feet. The general slope is north and northeasterly.

The mountainous portion of the area, confined entirely to Wyoming, is confined to the lofty Big Horn Mountains and to the Rattlesnake Range, the latter a short comparatively low mountain range bordering Sweetwater River basin to the south. While the east-facing slope of the Big Horn Mountains is quite steep, abrupt and in places precipitious, the hinterlands for the most part consist of undulating plateaus and rounded ridges, interspersed with a few rocky knolls and peaks with intervening sharply cut valleys and gorges. In the Cloud Peak region of the Big Horns in northwestern Johnson County, the ridges rise from 3,000 to 4,000 feet above the valleys and the general configuration is very rugged, presenting some of the boldest alpine scenery in the country. There are many precipices over 1,000 feet high and many of the steeper slopes consist of talus of huge granite blocks. Most of the topographic features of this high region are those characteristic of glacial erosion. The most marked of these are the many deep cirques that are cut back to the main divide. Glaciation or glacial deposits have produced most of the many small lakes found in this area. Diminutive remnants of glaciers are still to be found in the vicinity of Cloud Peak, lying in cirques cut deeply into some of the higher mountain slopes.

The rugged to roughly rolling foothills and valleys at the base of the mountain slope to the eastward have a great variety of surface features, characteristics of which are gravel-capped terraces, narrow bottomlands, flood plains, alluvial fans of gravel, sand and clay derived from erosion of the mountain slopes and small outlying uplifts. There are many deeply dissected steep, narrow valleys which have left benches and high mesas between the drainage courses.

Part of the Great Plains Province, the sharply rolling plains lie east and north of the belt of foothills and consist of comparatively broad tabular divides between the larger streams which are moreor less thoroughly dissected by narrow valleys of the lateral drainageways. The greater part of the area is characterized by a vast rolling to rough expanse of sharply rounded ridges and hills with occasional bold, conspicuous escarpments formed by the tilted edges of pine-covered sandstone which often form prominent land marks. Intervening valleys are often broad flats with numerous deep-cut gullies. The soft shales in places have eroded rapidly and the entire surface has been so

thoroughly dissected that the original plains character is suggested and represented now only by the crests of the main ridges which are all at about corresponding elevations. The topography along both sides of the Powder River from Sussex, Wyoming to Moorhead, Montana, is mainly of the badland type, especially close to the main stream and lateral tributaries, but there are found areas of more gentle relief as well. Vegetation is comparatively sparse, and the soft shales and sandstones are carved by runoff into an intricately dissected surface of steep raw slopes, extended escarpments and sharp ridges, buttes, domes, precipitious bluffs, pinnacles and vertical-walled gullies. One of the most outstanding and best known examples of badlands in the basin is "Hell's Half Acre" or "Devil's Kitchen", a small area of precipitious crags and needles in Natrona County, Wyoming. In limited parts of the area, burned-out coal beds along outcrops have left "scoria" or "slags", resistant masses of overlying baked clay as caps, ledges and small buttes. These slags, reddish-orange in color, cap or rim the upland areas and effectually retard the down-cutting of the drainageways to form miniature terraces. Drainage courses are intermittent, but during heavy downpours, the dry stream beds are filled with rushing torrents, sometimes 20 or 30 feet in depth. Erosion at such times is extremely rapid, great masses of shale caving from the steep banks into the water, there to be rapidly disintegrated and carried on downstream.

The gently rolling plains include several areas which have escaped thorough dissection and are comparatively smooth. One of the largest of these, comprising about ten townships in central Johnson County near Sussex, is locally known as the "Nine-Mile District". Other such areas in Wyoming are found as narrow belts along the eastern divide in Campbell County. Comparable areas are found in Montana, notably in the vicinity of Broadus. The undulating surface of these upland plains are often interrupted by the rough breaks of Powder River and its lateral tributaries. Pumpkin Buttes, four flat-topped buttes in southwestern Campbell County, resemble giant tepees and rise several hundred feet above the surrounding rolling country to form a conspicuous landmark in the southeastern part of the basin.

Geology

The rocks appearing at the surface within the Powder River basin afford a record of physical geology ranging from the Pre-Cambrian time to the present.

The Big Horn Mountains, forming an outlying portion of the Rocky Mountain Range, represents a great uplift by which a thick series of sedimentary rocks have been elevated high above the plains to the east. The deeply eroded crest of this uplift presents an exposed central nucleus of Pre-Cambrian granites and constitutes the floor of sedimentary deposits of more recent ages.

In the plains area, the geologic formations generally dip slightly to the east, but are modified locally by moderate to sharply dipping folds. The materials of the formations were derived mainly from the west and were deposited, layer by layer, either by streams on their flood plains or in lakes, or during even earlier times, in the sea.

The geologic formations present alternations of beds of various geologic materials, principally of sedimentary origin, shales, sandstones and limestones. These give rise to abrupt transitions in the character of their disintegration products, soils which differ widely in composition and agricultural capabilities often occurring side by side. The only areas in which the boundaries between different soils do not coincide with the boundaries of the rock formations are in the stream bottoms, in the areas of high-level gravel terraces, in many of the small tributaries, and upon steep slopes where transported soils have washed down and mingled with or covered the residual soils.

Drainage

The main stem of the river is roughly 155 miles in length in Wyoming and 120 miles in length in Montana and flows in a generally northeasterly direction. Its headwaters are near the geographical center of Wyoming. About three-fourths of the drainage area in Wyoming lies west of Powder River. Its largest tributaries are Clear, Crazy Woman, Salt and Buffalo Creeks, and North, Middle and South Forks of the Powder River. South Fork and Salt Creek are the only tributaries mentioned which might be considered as intermittent streams, although their drainage areas comprise almost one-fourth of the watershed above Moorhead Reservoir site. It is significant to note that all tributary drainages east of Powder River in Wyoming likewise flow only intermittently. The largest tributary in this portion of the area is Wild Horse Creek, which joins Powder River at Arvada, Wyoming. The principal tributaries which join Powder River below the site of the proposed Moorhead Reservoir are Little Powder, East Fork of Powder, Timber, Ash, Mizpah and Locate Creeks. These main tributaries and their small ones, form a mature and well established drainage pattern for the entire basin.

Powder River and its principal tributaries receive most of their water from the Big Horn Mountains in Wyoming and very little perennial runoff is yielded by the low altitude plains area. Elevations in the basin range from 2,250 feet at the mouth of the Powder River to a maximum of 13,165 feet at Cloud Peak in the Big Horn Mountains. The general stream gradient ranges from 2 feet per mile at the mouth to 30 feet per mile at the headwaters. Below the mountains, the main stream as well as its large tributaries have cut deeply entrenched channels into the sediments of the narrow valleys. The lower flood plains are usually dissected by the meandering flood channels of intermittent tributaries.

Soils

The soils of Powder River basin, like the soils of most of the semi-arid West, present a wide variation in soil development which differs materially in various parts of the area. Being derived in most cases from shale formations, they are often high in soluble salts and low in nitrogen. In places, capping of sandy materials over the shale formations has produced areas of sandy loams and loams, but generally speaking, heavy clay soils are dominant within the basin.

In general, soils of the flood plains, terraces, sloping benches, alluvial fans and stream bottoms are moderately deep, medium to heavy-textured

and usually adequately drained, although occasionally saline. Subsoils may be moderately heavy to tight. These are the most desirable soils for irrigation and where the relief is favorable for the distribution of water, there are found some of the most highly developed and valuable irrigated districts in the basin. Soils of poorly drained bottomlands are commonly silty or sandy over a gravel sub-stratum, occasionally slightly saline.

Soils on the more gently sloping uplands and benches are usually deep, moderately heavy clay soils with scattered areas of sandy clay loams developed from sediments washed down from areas of fine-grained sandstones. These soils are usually lighter in color than those of the irrigated lands and are situated in areas where dry-farming is practiced.

The greater part of the soils in the basin are shallow heavy soils on hilly to rough and broken uplands. On sloping benches adjacent to drainageways, the soils may be deep and moderately heavy to gravelly. They are unsuitable for cultivation due to one or more of the following factors: shallowness, stoniness, rough relief, frequent flooding by nearby streams, poor drainage, alkali accumulation, short growing season because of high elevations and inadequate moisture. The soils of this group include both the rough land of the dry plains and foothills and the rough and partly-forested mountain lands. Most of the public domain lands come within this category.

Vegetation

Ecologically, the basin has been differentiated into five life zones.(1) The Upper Sonoran Zone occupies the lower elevations and is followed, as the elevation increases, by the Transition, Canadian, Hudsonian and Arctic Alpine zones, in that respective order. Roughly speaking, the upper limits of each of the zones in this latitude may be considered to be 4,500 feet, 7,500 feet, 9,000 feet, 10,500 feet and above 10,500 feet, respectively.

About 96 percent of the basin is occupied by natural vegetation, the remaining four percent of the area comprising hay and croplands, water surfaces, roads and waste lands. Native vegetation, therefore, is the basis for the principal enterprise, the livestock industry, and is also the principal instrument through which the stabilization of the soil and improvement of the economy must be brought out. By judicious management, a maximum forage production can be attained and is indeed imperative. In the face of declining production on a considerable part of the native range lands, a large part of which is public lands, a vigorous program of constructive and united action is urgently needed to promote proper range and watershed management.

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(1) For a more complete description of the life zones, see North American Fauna No. 42; Life Zone Investigations in Wyoming; Fish and Wildlife Service, Department of the Interior.

The forage resources of the area have been delineated into four major types, namely, Timber, Open Mountain Parks, Sagebrush-Grass and Grass. Inaccessible and barren wastelands occupy parts of the basin. The timber type, based primarily upon the elevation, has been subdivided into three classes, the mountain timber type, the open pine type and the pine-savannah type.

The mountain timber type ranges from about 6,500 feet to 13,165 feet in elevation, occupies about three percent of the basin, and is confined to the Big Horn Mountains in Wyoming. The predominating specie are lodgepole pine (Pinus contorta), with spruce (Picea engelmannii) and fir (Abies lasiocarpa) occurring in small patches on the north slopes. Aspen (Populus tremuloides) border the conifers on the lower limits and extend along the live streams. The understory generally consists of a sparse growth of various grasses, shrubs, perennial and annual weeds. A litter of pine needles and organic matter forms a protective cover against soil erosion. Relatively unimportant as a source of summer forage for domestic livestock, the greatest benefits to be derived from this timber type are watershed protection for flood control and the conservation of moisture and for wildlife protection. A program of selective timber harvesting is being carried out in this type of the Big Horn National Forest which furnishes the principal supply of timber for the sawmill located in Buffalo, Wyoming, where approximately four million board feet of lumber is produced annually. Public land ownership within this type, except for the Big Horn National Forest, is relatively small.

The open pine type, ranging from about 3,500 feet to 5,000 feet in elevation comprises about four percent of the basin. It occupies part of northeast Sheridan and northwest Campbell Counties, Wyoming, and southwest Powder River County, Montana, and portions of the Powder River breaks. The open stands of yellow pine timber are commercially unimportant as saw timber because of their scattered location, but the vegetation in this type furnishes an important source of livestock forage, especially for cattle. The principal specie of grass in this type are wheatgrasses (Agropyron spp), blue grass (Poa spp), and blue grama (Boutelona gracilis). An estimated 20 percent of this type occurs on public domain lands.

The pine-savannah type, ranging from about 3,000 feet to 4,500 feet in elevation and comprising about five percent of the basin, occupies the higher elevations of the watershed divide in Montana and in Campbell County, Wyoming. The yellow pine is considerably more scattered than is found in the open pine type and is very often associated with sandstone or scoria outcrops. The principal forage specie are wheatgrasses, blue grama and niggerwool. Public land ownership varies from 5 to 15 percent within this type and consists of relatively small scattered tracts.

The open-mountain park type ranging from about 7,500 feet to 12,000 feet in elevation occupies about five percent of the basin and is found exclusively in the Big Horn Mountains in Wyoming. The principal specie are sedges (Carex spp.), blue grasses, wheatgrasses, fescues (Festuca spp.), phlox (Phlox spp.), old man whiskers (Siversia spp.), cinquefoil (Potentilla spp.), lupine (Lupinus spp.), balsam root (Balsamorrhiza spp.) and mountain dandelion (Agoseris spp.). These plants are vigorous and furnish adequate

cover for protection against soil erosion except in localized over-grazed areas such as in the vicinity of public stock driveways. This type furnishes summer grazing for sheep and cattle from about June 15 or July 1 to October 1st. Except for stock driveway withdrawals and National Forest lands, public land ownership within this type is comparatively small.

The sagebrush-grass type occupies areas from 3,000 feet to 7,500 feet in elevation and comprises about one-third of the range area in the basin. The greater part of this type occurs in Wyoming and in large part is coextensive with the Powder River breaks and heavy shale areas. The principal specie in this type are blue steam wheatgrass, niggerwool, big sagebrush (Artemisia tridentata), needle and thread grass (Stipa comata), blue grama prickley pear (Opuntia polyacantha), valley sage (Artemisia cana), brown sage (Artemisia pedatifida), silver sage (Artemisia frigida), winter fat (Eurotia lanata), rabbit brush (Chrysothamnus spp.). Some greasewood (Sarcobatus vermiculatus) occurs along the creek bottoms and on saline flats. Along the mountain front there are small patches of curlleaf mountain mahogany (Cercocarpus ledifolius) and juniper (Juniperus spp.). Grasses constitute about two-thirds of the forage used by livestock. This type presents varied degrees of plant vigor, composition and erosion conditions. It is unquestionably the heaviest and most extensive silt producer in the basin when compared with all vegetative types. It is best adapted for winter grazing by either cattle or sheep and receives its greater use during this period. Some of the type is used as year-long range, principally by cattle, while much of the type which lies adjacent to summer range of the mountains is used as spring-fall range. It is estimated that nearly one-half of all public domain in the basin is characterized by this type of vegetation.

The short-grass type is the most extensive vegetative type in the basin. It occupies nearly one-half of the range area and extends to elevations of about 6,500 feet. The principal specie are blue grama, niggerwool, blue stem wheatgrass, June grass (Koleria cristata), needle and thread grass (Stipa comata). Other important specie are blue grass (Poa secunda), salt grass (Distichlis stricta), blue bunch wheat grass (Agropyron spicatum), cheat grass (Bromus tectorum), black sage, brown sage, silver sage, phlox (Phlox hoodii), lambsquarter (Chenopodium alba), plantain (Plantago purshii), Russian thistle (Salsola pestifer) and cactus (Opuntia spp.). Shrubs usually constitute only a small part of the forage composition. The wheat grasses have become extensively established throughout the area and are by far the most vigorous and dominant in this type. This type is best adapted to summer and spring-fall grazing, although year-long grazing is extensively practiced by cattle operators. The foothills range adjacent to the Big Horn Mountains is used mainly for spring, fall and winter sheep range in connection with irrigated ranch headquarters. An estimated one-third of the public domain is found in this type.

ECONOMIC AND CULTURAL DEVELOPMENT

Population

Total population in the Powder River basin in 1940 was approximately 17,000 people, about 12,000 of which were rural-farm and approximately 5,000 living in communities and villages ranging in size from 10 to 2,800. The total population in 1930 was 21,000, a net decrease during the decade of 21 percent. This downward trend was accelerated by the prolonged drought period of the 1930's. The rural-farm populations decreased during this time, whereas the communities and villages increased. The 1940 population of the basin comprised about eight percent of the entire population of the Yellowstone River basin (212,260). In 1940, the average number of inhabitants per square mile in the Wyoming portion of the basin was 1.5, while in Montana it was 0.8. Powder River basin included eight percent of the total land area and only five percent of the total population of Wyoming; while that portion in Montana comprised three percent of the total land area and less than one percent of the total population.

Buffalo, Wyoming, the county seat of Johnson County, is the largest town in the Powder River basin, with an estimated 2,800 residents, which is about 16 percent of the total population of the basin. It is situated at the foot of the Big Horn Mountains at an elevation of 4,635 feet and serves as an important marketing and shipping center for a large livestock and agricultural region in Wyoming. The Wyoming Railway, a small independent line, connects Buffalo with the C. B. and Q. Railroad at Clearmont in Sheridan County. Buffalo enjoys all the advantages of natural beauty in its mountain setting and is fast becoming an important summer resort center. A lumber mill was established at Buffalo in 1944 and has already become an important part of the economic life of the community, cutting more than four million board feet of lumber annually. Mining is done on a small scale with two coal mines near Buffalo furnishing about 6,000 tons of coal annually for local use.

Midwest, Wyoming, an oil town with a population of about 1,000 inhabitants and the second largest town in the basin, is located in the Salt Creek Oil Field in northeastern Natrona County.

Broadus, Montana, third largest town, with a population of about 240 residents, is the county seat of Powder River County.

There are several rural schools in the area and consolidated high schools are located at Buffalo, Midwest, Clearmont and Broadus within the area and at the nearby towns of Casper, Sheridan, Gillette and Miles City. Plans are being made by the state officials for the opening of the University of Wyoming School of Agriculture at Sheridan, Wyoming, as a branch of the State University.

Markets and Transportation

The C. B. and Q. Railroad crosses the central part of the basin, entering on the east near Gillette, Wyoming, crossing Powder River at Arvada and continuing by way of Clearmont and Ulm to Sheridan, Wyoming, and Billings, Montana. An independent line, the Wyoming Railroad, terminating at Buffalo, Wyoming,

connects with the C. B. and Q. at Clearmont, Wyoming, 25 miles to the north. The principal shipping centers for this area are Gillette, Arvada, Clearmont, Buffalo and Sheridan, Wyoming. The Northern Pacific and Milwaukee railways traverse Yellowstone River Valley and provide outlets for the northern portion of the basin at Miles City and Terry, Montana.

The C. B. and Q. and the Chicago-Northwestern railways provide convenient outlets for farm products and livestock in the southern portion of the basin. Both lines traverse the basin on common trackage entering at Powder River, Wyoming on the east side and leaving the basin on the west at Arminto, Wyoming. The principal shipping centers for this area are Casper, Bucknum, Powder River and Arminto, Wyoming.

There are no railways traversing the basin in a north and south direction, but an oiled highway, U. S. No. 87 provides for excellent highway transportation from Casper to Sheridan. Oiled highways for east and west travel across the basin are U.S. No. 12, U.S. No. 14, U.S. No. 16 and U.S. No. 20. U.S. No. 212 connecting Belle Fourche, South Dakota and Miles City, Montana, crosses Powder River near Broadus. This all-weather highway provides the principal farm-to-market outlet for the greater part of the basin in Montana.

A network of State highways and County roads provides good farm-to-market routes. All of the Federal highways are maintained for year-round travel. The county roads are for the most part improved dirt roads, many of which in the remote areas are closed during the winter. Many secondary roads become virtually impassable for short periods during wet weather.

Industries

Farming and livestock raising are the principal industries of the basin engaging a large portion of the total working population. The estimated value of crops and livestock sold in 1945 was $11,000,000. Petroleum products in the same year had an estimated total value of $5,500,000. Small scale lumbering exceeded $150,000 in value and coal mined and sold commercially had a value of about $50,000 in 1945. Other industries of importance are tourism, construction, service trades and rail and truck transportation.

LAND OWNERSHIP AND TENURE

The land ownership and tenure picture is of great importance in working out and securing a sound and efficient land management program. Of the approximately 8,443,000 acres in the basin, about 70 percent lies in Wyoming and the remaining 30 percent in Montana. Two Taylor grazing Districts encompass 30 percent of the gross area and National Forests comprise about 3½ percent of the total watershed. The complexity of land ownership is best illustrated by the fact that there are 13 classes of land ownership. Federal, State and County lands comprise 35.3 percent of the basin and privately owned and railroad lands make up the remaining 64.7 percent.

A total of 1,830,953 acres, or about 22 percent of all lands in the basin are under the custody of the Bureau of Land Management, of which approximately 471,888 acres are in grazing district. (See Table 4.) The greatest

Table 4 - Land Ownership by State and County
Above and Below Moorhead Reservoir, 1949
Powder River Basin

	ABOVE MOORHEAD RESERVOIR									
	WYOMING							Montana Powder River County Acres	Total Montana and Wyoming	
	Campbell County Acres	Converse County Acres	Johnson County Acres	Natrona County Acres	Sheridan County Acres	Washakie County Acres	Wyoming Total Acres		Acres	Per-cent
Lands Administered by Bureau of Land Management:										
Public Domain	118,720	320	510,913	464,596	35,420	4,250	1,134,219	13,267	1,147,486	13.6
Within Grazing Districts	- - - -	- - - -	- - - -	- - - -	- - - -	(130)	(130)	(13,267)	(13,397)	(1.1)
Outside Grazing Districts	(118,720)	(320)	(510,913)	(464,596)	(35,420)	(4,120)	(1,134,089)	- - - -	(1,134,089)	(12.5)
Stock Driveway Withdrawals	360	- - - -	30,340	100,320	1,740	10,040	142,800	- - - -	142,800	1.7
Public Water Reserve	120	- - - -	- - - -	160	120	40	440	40	480	- -
Air Navigation Sites	- - - -	- - - -	- - - -	60	- - - -	- - - -	60	- - - -	60	- -
National Forests	- - - -	- - - -	270,184	- - - -	3,680	- - - -	273,864	- - - -	273,864	3.2
Naval Petroleum Reserve	- - - -	- - - -	- - - -	9,320	- - - -	- - - -	9,320	- - - -	9,320	0.1
State	61,225	- - - -	219,157	147,562	33,461	5,080	466,485	4,176	470,661	5.6
Private	704,575	3,280	1,567,166	419,172	257,599	26,600	2,978,392	20,369	2,998,761	35.5
Railroad	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- -
Land Utilization Purchase (S.C.S.)	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- -
County	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- -
Indian Allotment	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- -
Total	885,000	3,600	2,597,760	1,141,190	332,020	46,010*	5,005,580*	37,852	5,043,432	59.7

	BELOW MOORHEAD RESERVOIR									
	Wyoming			MONTANA					Total Montana and Wyoming	
	Campbell County Acres	Crook County Acres	Wyoming Total Acres	Powder River County Acres	Carter County Acres	Custer County Acres	Prairie County Acres	Montana Total Acres	Acres	Per-cent
Lands Administered by Bureau of Land Management:										
Public Domain	80,141	1,535	81,676	238,781	104,420	109,779	5,471	458,451	540,127	6.4
Within Grazing Districts	- - - -	- - - -	- - - -	(238,781)	(104,420)	(109,779)	(5,471)	(458,451)	(458,451)	(5.4)
Outside Grazing Districts	(80,141)	(1,535)	(81,676)	- - - -	- - - -	- - - -	- - - -	- - - -	(81,676)	(1.0)
Stock Driveway Withdrawals	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - -
Public Water Reserve	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - -
Air Navigation Sites	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - -
National Forests	- - - -	- - - -	- - - -	5,777	3,388	- - - -	- - - -	9,165	9,165	0.1
Naval Petroleum Reserve	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - -
State	60,416	70	60,486	113,623	47,051	49,242	3,590	213,506	273,992	3.3
Private	694,083	11,255	705,338	903,314	169,579	573,538	15,127	1,661,558	2,366,896	28.0
Railroad	- - - -	- - - -	- - - -	30,229	11,963	28,725	22,884	93,801	93,801	1.1
Land Utilization Purchase (S.C.S.)	37,420	- - - -	37,420	- - - -	- - - -	35,601	17,881	53,482	90,902	1.1
County	- - - -	- - - -	- - - -	4,281	11,497	8,864	- - - -	24,642	24,642	0.3
Indian Allotment	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	308	308	308	- -
Total	872,060	12,860	884,920	1,296,005	347,898	805,749	65,261	2,514,913	3,399,833	40.3

	ENTIRE WATERSHED					
	Montana		Wyoming		Total Watershed Montana and Wyoming	
	Acres	Per-cent	Acres	Per-cent	Acres	Per-cent
Lands Administered by Bureau of Land Management:						
Public Domain	471,718	5.6	1,215,895	14.4	1,687,613	20
Within Grazing Districts	(471,718)	(5.6)	(130)		(471,848)	(5)
Outside Grazing Districts	- - - -	- -	(1,215,895)	(14.4)	(1,215,765)	(15)
Stock Driveway Withdrawals	- - - -	- -	142,800	1.7	142,800	1.7
Public Water Reserve	40	- -	440	- -	480	
Air Navigation Sites	- - - -	- -	60	- -	60	
National Forests	9,165	0.1	273,864	3.3	283,029	3.4
Naval Petroleum Reserve	- - - -	- -	9,320	0.1	9,320	0.1
State	217,682	2.6	526,971	6.2	744,653	8.8
Private	1,681,927	19.9	3,683,730	43.6	5;365,657	63.5
Railroad	93,801	1.1	- - - -	- -	93,801	1.1
Land Utilization Purchase (S.C.S.)	53,482	0.6	37,420	0.5	90,902	1.1
County	24,642	0.3	- - - -	- -	24,642	0.3
Indian Allotment	308	- -	- - - -	- -	308	
Total	2,552,765	30.2	5,890,500	69.8	8,443,265	100

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* Includes 2,480 acres in Tensleep Grazing District No. 1

concentrations of public domain lands occur in the southern portion of the basin in Wyoming (See map appendix). Lands administered by the Bureau of Land Management dominate all other classes of land ownership in the entire area drained by the North, Middle and South Forks of Powder River and Salt Creek in Natrona and southern Johnson Counties. In a large part of this area, it comprises more than 70 percent of the total land area. This pattern persists in the breaks along the main stem of the Powder River in Wyoming; but the public lands become progressively more widely scattered as the Montana State Line is approached. In Montana, the public domain is relatively compact in the breaks of Powder River, although small tracts are promiscuously scattered throughout the basin. The watershed east of Powder River in Carter and Powder River Counties contains heavy concentrations of public domain. A comparatively regular checkerboard pattern of public domain exists in Custer County, due primarily to alternate sections of railroad land, much of which has now passed to private ownership.

In some parts of the basin, public domain lands are a minor part of the land setup. In such areas, the public domain consists of scattered and isolated remnants, the "leftovers" of an era of land settlement which had its greatest impetus following the enlarged Homestead Act of 1916. In central and northwestern Johnson County, specifically in the drainage basins of Crazy Woman and Clear Creeks, there is an area of more than a million acres, of which less than three percent is public domain. The same condition exists in the Clear Creek watershed in Sheridan County. In these localities and only in rough areas along Powder River are there found any relatively compact blocks of public domain. Public domain in Campbell County consists for the most part of relatively scattered tracts. About one-half of the total area in this county contains an average of less than three percent Federally owned lands, while in the remaining area, the public lands lie in relatively compact blocks. In Montana, the public domain is of minor significance in about one-third of the basin, chiefly in northwestern Powder River County and in the extreme southern part of Custer County. Detailed studies are needed to classify such isolated tracts and to determine their most efficient and practical method of disposition or management.

WATER RESOURCES

Water resources of Powder River Basin are now used chiefly for irrigation with important but less extensive use for municipal water supply and stock water. Power generation is limited at present to one small plant at Buffalo, Wyoming. Power is imported from other basins. The average annual discharge at the mouth of the Powder River, during the ten-year period from 1931 to 1940, was 310,000 acre feet, approximately five percent of the average annual discharge (6,870,000 acre feet) of the entire Yellowstone River Basin. (See Table 5.)

Table 5 - Surface Water Resources
Powder River
Sources of Run-off (1)

Stream	Location	Drainage Area Square Miles	Average Annual Run-off in Acre Feet - 1931-1940
Piney Creek	Kearney, Wyoming	106	63,770 (2)
Clear Creek	Near Arvada, Wyoming	1,110	153,600 (2)
Crazy Woman Creek	Near Arvada, Wyoming	948	37,180 (2)
North Fork Powder	Mayoworth, Wyoming	69	(3)
Middle Fork Powder	Kaycee, Wyoming	980	106,200 (2)
Powder River	Arvada, Wyoming	6,050	187,600
Powder River	Moorhead, Montana	7,880	277,600
Little Powder	Biddle, Montana	1,450 (App.)	17,470 (2)
Powder River	Mouth of River, Montana	13,193	310,000 (2)

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(1) Source: U. S. Geological Survey.
(2) Water year 1941-42 only.
(3) Insufficient data.

In general, the streams which emerge from the Big Horn Mountains run for several miles in an easterly direction, then turn northeastward toward Powder River. It is along these valley streams and their tributaries that most of the irrigated crop and hay lands are to be found, and where the most diversified and profitable agricultural areas are located. During the irrigating season, all normal flow is diverted and a water shortage sometimes occurs during some seasons on part of the irrigated lands. Additional lands are topographically suitable for irrigation, but in such areas the present supply of water is insufficient. Ordinarily, the streams emerging from the forest areas of the Big Horn Mountains are clear, fed by numerous springs and lakes. They become muddy and silt-laden only in periods of heavy run-off. On the other hand, streams rising from some of the more impoverished soil areas, such as are found on South Fork and Salt Creek watersheds, are invariably heavily laden with silt.

The potential opportunities for ground water recovery within the basin vary considerably because of the dissimilarity of geologic materials and structural conditions. The quality of ground water is good in most cases and becomes better as the mountainous west boundary is approached. No areas are known to exist where underground water occurs in sufficient quantity for irrigation to encourage additional well developments. However, according to reports of the U. S. Geological Survey, artesian flows occur irregularly along the Powder River. Thousands of small stock-watering-reservoirs have been constructed primarily due to the lack of subsurface water supplies. In many of the lower elevation range areas, the reservoirs are the only source of water for livestock.

Irrigation began in the late 1880's, near Buffalo, chiefly for production of livestock feed. Dependable but fairly limited water supplies were available along the base of the Big Horns, and it was only natural that such areas were first developed for irrigation. Rapid expansion took place from 1900 to 1920, during which period nearly all the existing projects were developed.

Existing water facilities consist of stock water reservoirs, wells, direct flow irrigation systems, storage reservoirs, several individual irrigation pumping plants, flood water diversions and springs. Small lakes are abundant in the Big Horn Mountains at elevations in excess of 8,000 feet. Lake DeSmet, the largest body of water in the basin, has an area of 2.7 square miles, and is located eight miles north of Buffalo, Wyoming. Its present storage capacity is about 35,200 acre-feet, and plans of the Bureau of Reclamation call for an increase of 44,000 acre-feet in its capacity. Water is diverted from Piney Creek into this reservoir to augment the comparatively small flow obtained from Shell Creek. An annual interstream diversion of 9,000 acre-feet of water is taken from Piney Creek, a tributary of Clear Creek, for use on irrigated lands in the Tongue River Basin, Wyoming.

Present irrigation developments utilize practically all the available surface water supply, and any further increase in irrigation developments will be dependent upon supplemental storage above existing developments. According to Bureau of Reclamation estimates, there are approximately 42,600 acres of additional land suitable for irrigation below Moorhead Reservoir and 44,360 acres above. Substantially, all such proposed irrigation development would be on private lands. Table 6 depicts the plan of reservoir developments in Powder River Basin as presented in Senate Document No. 191, "Missouri River Basin".

An additional reservoir known as the Camp Comfort project, which was not included in Senate Document No. 191, is being studied by the Bureau of Reclamation as a possible irrigation storage and power site. Situated in the Big Horn Mountains, six of the proposed reservoirs will provide not only additional storage facilities, but will aid in the control of run-off during periods of high water and will greatly reduce the silt flow down the Powder River.

Table 6 - Reservoirs Proposed by
Bureau of Reclamation
Powder River Basin

Reservoir	Stream	Unit Served	Total Capacity Acre Feet	Purpose
Wyoming				
Willow Park	South Fork Piney Creek	Piney	9,700	Irrigation
Triangle Park	South Fork Rock Creek	Buffalo	4,000	Irrigation
Bull Creek	Clear Creek	Buffalo	14,000	Irrigation and Flood Control
Lake DeSmet	Piney Creek	Ucross (1)	44,000	Irrigation
Smith	North Fork Powder River	Crazy Woman, Mayoworth and North Fork	30,000	Irrigation and Flood Control
Middle Fork	Middle Fork Powder River	Kaycee	50,000	Irrigation, Flood Control and Silt Control
Montana				
Moorhead	Powder River	Moorhead (2)	700,000	Irrigation, Flood Control and Silt Control
			851,700	

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(1) Increase in present capacity of 35,200 acre-feet.
(2) Principally regulatory for flood and silt control; approximately 390,000 acre-feet for irrigation purposes in Montana.

MAJOR LAND USES

Livestock Production

The production of range beef cattle and sheep is the predominating agricultural enterprise in Powder River Basin. More than ninety-five percent of the area is devoted to livestock ranching and farming, and it is unlikely that much of the area will ever be put to much more intensive use until additional reclamation projects are developed.

Sheep predominate in the southern part of the basin. The majority of them are grazed in the summer on the Big Horn Mountains and on the plains and foothills region for the remainder of the year. Some cattle are handled in much the same manner, many of them being summer grazed on the Big Horn National Forest for a period of 3 to 3½ months. For the most part, however, cattle ranches are located in areas of year-long operations, including winter range and sufficient supplemental feed to carry over during the winter feeding season. The dominant use of the winter range area is made by sheep operators who are dependent upon seasonal migration to round out their year-long livestock operations.

The estimated number of livestock within Powder River basin for the year 1945 was 641,700, consisting of approximately 192,600 cattle, 433,500 sheep and 15,600 horses. This number of livestock is equivalent to 294,900 animal units, calculated on the basis that five sheep are equivalent to one horse or one cow. Cattle, therefore, comprise 65 percent, sheep 30 percent and horses 5 percent of the livestock population in the basin. Almost 75 percent of the total livestock population are found on Wyoming ranches and the remainder are in Montana. About two-thirds of the total animal units are found above the proposed Moorhead reservoir.

The health of livestock in the basin is generally good, and they are relatively free from disease.

Severe winter and spring storms are a constant threat to the stability of sheep operations. Sheep losses, for example, in Natrona County alone were estimated at $125,000 in the wake of a snowstorm which blanketed the area on June 20-21, 1947. Severe winter storms of 1948-49 caused much distress and heavy loss among livestock.

Predator losses are diminishing each year as a result of the active control programs of Federal, state and county agencies and various livestock associations.

Crop Production

Three percent of the land in the basin is devoted to crop production, about two-thirds of which is dry farmed. (See Table 7.) Crop production under irrigation, dry land farming and flood irrigation prevail under widely diverse conditions. The crops grown may be divided into three groups; grain crops, hay and forage crops and miscellaneous crops. For the year 1945, the hay and forage crops comprised about 61 percent of the total cropland acreage, grain crops made up about 26 percent, miscellaneous crops about 5 percent, idle or fallow land 7 percent, and crop failure constitutes the remaining one percent of the cropland acreage. These proportions vary from year to year, but hay and forage crops will very likely always be in the majority because of their close relationship to the livestock industry in the basin and to climatic limitations.

Alfalfa and other tame hay were grown on about 88,000 acres, yielding approximately 104,000 tons. Native hay was cropped from about 68,000 acres, with a total yield of approximately 55,000 tons. Winter and spring wheat, the principal crops grown for sale, comprised approximately 53 percent of the harvested acreage of small grains for the year 1944; oats 31 percent and barley

Table 7 - Crop Production in
Powder River Basin
By State and County - 1945 (1)

	WYOMING					MONTANA					TOTAL MONTANA AND WYOMING
	Campbell County	Johnson County	Natrona County	Sheridan County	Total Wyoming	Carter County	Custer County	Powder River County	Prairie County	Total Montana	
SMALL GRAINS:											
Winter Wheat:											
Acres	9,000	120	- - - -	700	9,820	- - - -	1,000	4,100	50	5,150	14,970
Bushels	151,000	3,500	- - - -	14,700	169,200	- - - -	19,200	96,100	800	116,100	285,300
Spring Wheat:											
Acres	4,600	4,600	- - - -	2,200	11,400	500	3,300	8,300	1,000	13,100	24,500
Bushels	58,000	95,300	- - - -	50,000	203,300	6,500	46,500	156,000	15,000	224,000	427,300
Oats:											
Acres	4,800	4,557	- - - -	1,300	10,657	200	1,300	3,900	50	5,450	16,107
Bushels	105,000	171,400	- - - -	50,000	326,400	5,500	39,000	132,000	1,200	177,700	504,100
Barley:											
Acres	1,800	3,263	- - - -	1,800	6,863	400	1,300	2,400	100	4,200	11,063
Bushels	27,000	115,600	- - - -	55,000	197,600	7,500	29,000	92,000	2,600	131,100	328,700
Total Small Grains - Acres	20,200	12,540	- - - -	6,000	38,740	1,100	6,900	18,700	1,200	27,900	66,640
Total Small Grains - Bushels	341,000	385,800	- - - -	169,700	896,500	19,500	133,700	476,100	19,600	648,900	1,545,400
HAY:											
Alfalfa:											
Acres	7,900	21,507	- - - -	4,000	33,407	400	5,000	24,600	200	30,200	63,607
Tons	7,300	32,873	- - - -	7,000	47,173	450	5,500	26,800	300	33,050	80,223
Native Hay:											
Acres	16,400	10,463	2,163	3,893	32,919	2,800	10,000	21,450	900	35,150	68,069
Tons	12,100	8,700	1,600	3,300	25,700	2,100	7,600	19,000	700	29,400	55,100
Other Tame and Grain Hay:											
Acres	4,000	7,475	- - - -	2,200	13,675	500	1,700	8,300	100	10,600	24,275
Tons	3,000	9,468	- - - -	2,600	15,068	500	1,300	7,000	100	8,900	23,968
Total Hay - Acres	28,300	39,445	2,163	10,093	80,001	3,700	16,700	54,350	1,200	75,950	155,951
Total Hay - Tons	22,400	51,041	1,600	12,900	87,941	3,050	14,400	52,800	1,100	71,350	159,291
SUGAR BEETS:											
Acres	- - - -	88	- - - -	900	988	- - - -	- - - -	- - - -	- - - -	- - - -	988
Tons	- - - -	781	- - - -	9,100	9,881	- - - -	- - - -	- - - -	- - - -	- - - -	9,881
MISCELLANEOUS CROPS:											
Acres	2,200	1,600	- - - -	1,255	5,055	485	1,600	3,000	100	5,185	10,240
CROP FAILURE:											
Acres	500	137	- - - -	500	1,137	100	800	150	- - - -	1,050	2,187
CROPLAND:											
Irrigated Land (2)											
Acres	8,400	41,659	2,163	9,893	62,115	500	11,300	25,500	800	38,100	100,215
Dry Farm Land											
Acres	47,600	13,213	- - - -	10,355	71,168	5,585	17,500	58,000	1,800	82,885	154,053
Total Cropland - Acres	56,000	54,872	2,163	20,248	133,283	6,085	28,800	83,500	2,600	120,985	254,268

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(1) Source: U. S. Agriculture Census - 1945.
(2) Includes irrigated hayland and pastures.

16 percent. The latter two crops are grown chiefly for feed. The sugar beet acreage, at the present time is confined exclusively to Clear Creek and Piney Creek in Johnson and Sheridan Counties; totalled nearly 1,000 harvested acres in 1944, and yielded slightly more than 10 tons per acre. The sugar beets are shipped to the sugar factory at Sheridan for refining. Statistical data pertaining to the value of crops and livestock in Powder River Basin are shown in Table 8.

Table 8 - Value of Principal Crops and Livestock and Number of Farms in Powder River Basin by Counties - 1945 (1)

County	Value of Crops Harvested (Dollars)	Value of Crops Sold (Dollars)	Total Value of Livestock (Dollars)	Value of Livestock and Livestock Products Sold (Dollars)	Number of Farms
Wyoming					
Campbell	860,000	200,000	3,970,000	2,000,000	330
Crook			40,000	20,000	3
Johnson	1,166,410	163,200	5,050,000	2,850,000	386
Natrona	17,000		1,640,000	1,040,000	90
Sheridan	518,000	174,000	1,110,000	940,000	140
Washakie			30,000	20,000	8
Total Wyoming	2,561,410	537,200	11,840,000	6,870,000	957
Montana					
Carter	64,000	10,000	480,000	290,000	45
Custer	442,000	200,000	1,270,000	790,000	115
Powder River	1,500,000	540,000	3,530,000	1,670,000	399
Prairie	50,000	20,000	82,000	50,000	15
Total Montana	2,056,000	770,000	5,362,000	2,800,000	574
Total	4,617,410	1,307,200	17,202,000	9,670,000	1,531

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(1) Based on U. S. Census 1945, with adjustments.

Approximately 100,000 acres, including irrigated hayland and pasture, or about one percent of the basin is devoted to production of crops by irrigation. Irrigated land is confined mainly to the valleys of the carrier streams, Clear Creek, Piney, Crazy Woman Creeks and Powder River and lesser tributaries having their source in the Big Horn Mountains. Piney Creek waters are stored in Lake DeSmet. The water is generally ample for the land being irrigated, although in dry years, shortages occur. The most important crops grown are winter and spring wheat, oats, barley, alfalfa and sugar beets. Many of the ranches are of the so-called "shoestring" irrigation variety along the smaller streams. These ranches are operated on the basis of an adequate range forage supply nearby to support livestock six to nine months of the year. Extensive

irrigated farm developments are found along Clear Creek and Piney Creek in Sheridan and Johnson Counties and it is along these two streams where the greatest diversity in crop production is found.

The tributary streams rising in the Big Horn Range have the most reliable, though limited, flow and carry little silt. The waters are used extensively for irrigation which is carried on by means of individual or cooperative ditches. Little additional land can be irrigated until additional storage facilities are provided.

Comparatively little land above the proposed Moorhead reservoir is irrigated from Powder River, although the Bureau of Reclamation estimates that there are approximately 28,000 acres adjacent to the river which are suitable for farming by irrigation. The uncertainty of flow during the summer months, and the great amount of silt carried during high water makes Powder River unsuited for additional extensive irrigation at the present time. According to the Bureau of Reclamation, the construction of water storage facilities above Kaycee, however, will permit additional irrigation development on Powder River north of Sussex and will provide supplemental water to approximately 6,400 acres of existing cropland in the vicinity of Kaycee and Sussex. Originally developed as a Carey Act Project, 3,729 acres of the irrigated croplands lying adjacent to the river between Kaycee and Sussex are now supplied with water diverted from the Middle Fork west of Kaycee.

Approximately 154,000 acres, about 60 percent of the total cropland of the basin, are in dry farms. In Montana, nearly two-thirds of the dry farmland acreage occurs in Powder River County with scattered acreages in Custer, Carter and Prairie Counties. Most of the dry farms in Wyoming are confined to Campbell, Sheridan and northern Johnson Counties with limited areas in central Johnson and northern Natrona Counties.

Crop production by means of flood irrigation is the least common type, comprising only 24,131 acres. Most of the flood irrigated land lies adjacent to Powder River in Montana. Hay is the principal crop.

The livestock industry held undisputed control over most of the lands in the basin from about the time the Indians were placed on reservations in 1877 until about 1910 when homesteaders began settlement in the more productive areas. This influx was caused to a great extent by the passage of the 320 and 640 acre Homestead Acts. The expansion in dry farming was later stimulated by the introduction of the tractor, the combine, the one-way Wheatland disk plow and the furrow drill. As a result of successive drought years in the thirties, many dry farms and homesteads were abandoned. One of the most outstanding examples of such abandonment occurred in an area locally known as the "Nine-Mile District" in central Johnson County. Approximately one hundred families resided in this area in the twenties and early thirties as compared to about fifteen families at the present time.

The experiences of the last two decades are convincing proof of the erratic and wide variability in crop yields, crop failures and qualities of dryland farms in Powder River basin. This is illustrated by data for Campbell

County which is fairly typical of most of the dryland farms in the basin. These data show that in 1929, a relatively good crop year, 169,260 acres were seeded, of which 11,714 acres were a crop failure. In 1934, one of the drought years, 127,262 acres were seeded, of which 82,237 acres were a crop failure. Thus it is seen that within this short period, crop failures varied from seven percent in 1929 to sixty-five percent in 1934. In 1939 and 1944, generally considered to be excellent crop years, crop failures were about twelve percent and one percent respectively. There was a continual decrease in total cropland seeded, despite the stimuli provided by wartime demand and high prices during the last decade. Submarginal dry farm lands are constantly being retired from cultivation where experience has proven that they are more valuable and suitable for sustained livestock grazing use.

Forage Production

Range livestock numbers cannot be materially increased in Powder River basin without injury to the range resources until additional and supplemental development of irrigation and range management projects takes place. Present plans of the Bureau of Reclamation call for supplemental water supplies for approximately 44,000 acres of land in Wyoming above the proposed Moorhead reservoir. In Montana, it is estimated that 42,000 acres of land in Powder River basin can be provided with water below the projected Moorhead reservoir. Most of this additional irrigated acreage will likely complement the present livestock economy of the area by producing additional forage and feed. This should go far toward relieving or shortening the period of use on range lands which at present are being used too heavily. An increase in forage yields can be effected by such facilities as range reseeding, water spreading, fencing, water developments and by other rehabilitation practices.

Many ranchers have built up feed reserves for use during one or more subnormal seasons, not to provide feed for additional livestock, but to assure maintenance of the livestock in adverse years. Many others, however, are not so fortunately situated and are dependent almost wholly upon the range resources and supplemental feed purchases. A decrease in the supply of native forage as the result of too many grazing animals or drought necessitates the increased use of supplemental feeds or reduction in numbers of livestock. In either event, the net result is reduction in income.

Supplemental feed provides not only reserves for seasons of subnormal range forage production, but makes deferred grazing possible on areas where the vegetative cover is injured by early spring grazing. It also supplements native range and pastures during normal seasons and thereby promotes the well-being of the livestock.

MINERALS

Mineral production of the basin includes oil, natural gas, coal and bentonite; and in 1945 had an estimated value of approximately $6,000,000. Small gold placer deposits have been worked in the past along Kelly Creek, Johnson County, Wyoming, but these are relatively unimportant.

Petroleum

There are a number of oil and gas fields in the basin, the largest of which is the Salt Creek oil and gas field in Natrona County, Wyoming. The output of this field is piped to Casper, Wyoming, for refining. (See Table 9.) Nearly all of the towns in central Wyoming as well as those in the basin are supplied with natural gas piped from this field, with one line extending into Nebraska.

Naval Petroleum Reserve No. 3, more commonly known as "Teapot Dome", is located adjacent to the Salt Creek field. This reservation embraces 9,320 acres and has not been in production since 1928.

Seismograph field studies and wildcat drilling were very active during the past three years in a large part of the Powder River basin. A wildcat well, drilled by a major oil company, added impetus to oil land leasing in Powder River basin when a good show of oil was reported in October, 1947. This wildcat, known as the "Adon Well" lies in the Little Powder River drainage about 15 miles north of Gillette, Campbell County, Wyoming. Its location was based on seismic work accomplished during the previous two years. Unitization of its Adon Block has been completed, and it is now reported to have about 40,000 acres included in the unit area. Virtually all lands in this vicinity and extending into Powder River County, Montana, have now been leased to oil operators and increased exploratory activity is expected. It is estimated that more than a million acres of land in the Powder River basin, much of which is public domain, was leased following discovery of the Adon Well. The west side of the basin flanking the Big Horn Range in Johnson County, Wyoming, is receiving considerable attention at the present time, and drilling is planned on several wildcat blocks in this area. Extensive areas of public domain are likewise to be found in this area.

Bentonite

The production of bentonite in the basin is very limited at the present time, the chief obstacle being the long distance to markets. Commerical quantities occur, however, in several areas, and increased activity and interest are being taken in development of this resource. While insufficiently prospected as yet, the bulk of the known deposits of bentonite appears to occur in areas where public lands are dominant.

Coal (1)

Coal of lignite and sub-bituminous grade is widely distributed throughout the basin and is being produced in commercial quantities near Buffalo, where output varies from 6,000 to 10,000 tons annually. Sub-bituminous coal resources in the basin are practically undeveloped, limited to small amounts taken by ranchers for their own use and with some commercial production for

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(1) The compiled data were obtained from several U. S. Geological Survey publications, the principal source being U. S. Geological Survey Professional Paper No. 100 A 1922, "Coal Fields of the United States" by Marius Campbell.

Table 9 - Production Record of Oil Fields in Powder River Basin, Wyoming (1)

Field	County	Discovery Year	Proven Area (Acres)	Product	All lands Total Cumulative Production through 1945	All lands Total Production 1945	Public Lands Production 1945	Government Royalty Production 1945	Royalty Value 1945 (Dollars)
Shannon	Natrona	1889	55	Oil (Bbls.)	53,441	------	------	-----	-----
				Gas (Cu. ft.)	------	------	------	-----	1,715
				Gasoline and Butane (Gals.)	------	------	23,496,930	838,051	250,703
Salt Creek No. 2	Natrona	1906 and 1929	21,450	Oil (Bbls.)	314,771,071	4,151,115	------	466,755	592,742
				Gas (Cu. ft.)	386,250,000	2,792,000	320,551	34,299	-----
				Gasoline and Butane (Gals.)	------	------	1,545,412	65,174	2,672
Salt Creek No. 1	Natrona	1930	1,000	Oil (Bbls.)	2,614,679	499,499	------	22,563	30,958
				Gas (Cu. ft.)	------	------	------	-----	-----
				Gasoline and Butane (Gals.)	------	------	------	-----	-----
East Teapot) West Teapot)	Natrona	1922	40	Oil (Bbls.)	139,106	4,724	------	237	355
				Gas (Cu. ft.)	------	------	------	-----	-----
				Gasoline and Butane (Gals.)	------	------	------	-----	-----
Notches Dome	Natrona	1923	420	Oil (Bbls.)	569,830	123,169	------	6,158	3,883
				Gas (Cu. ft.)	------	------	------	-----	-----
				Gasoline and Butane (Gals.)	------	------	------	-----	-----
Boone Dome	Natrona	1923	400	Oil (Bbls.)	1,257,000	12,000	------	-----	-----
				Gas (Cu. ft.)	------	9,898	9,898	495	30
				Gasoline and Butane (Gals.)	------	------	------	-----	-----
Powder River	Natrona	1923	300	Oil (Bbls.)	41,000	2,000	------	-----	-----
				Gas (Cu. ft.)	------	1,792	1,792	90	4
				Gasoline and Butane (Gals.)	------	------	------	-----	-----
Billy Creek	Johnson	1923	710	Oil (Bbls.)	------	------	------	-----	-----
				Gas (Cu. ft.)	3,182,000	------	------	-----	-----
				Gasoline and Butane (Gals.)	------	------	------	-----	-----
Total				Oil (Bbls.)	319,446,127	4,792,507	------	495,713	627,938
				Gas (Cu. ft.)	389,432,000	2,803,690	332,241	34,389	1,749
				Gasoline and Butane (Gals.)	------	------	25,042,342	903,225	253,375
Naval Petroleum Reserve No. 3 (2)	Natrona	1922	3,000	Oil (Bbls.)	3,543,282	------	------	484,329	787,284
				Gas (Cu. ft.)	5,162,869	------	------	838,124	52,719
				Gasoline and Butane (Gals.)	------	------	2,483,896	82,796	8,945

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(1) Progress Report 1945, U. S. Geological Survey, Conservation Branch, Oil and Gas Leasing Division.

(2) Production from 1922 to 1928 inclusive.

local consumption in the vicinity of Buffalo, Clearmont, Arvada and Gillette, Wyoming, and Broadus, Montana. The abundance of workable coal seams in the proximity of railroad transportation facilities in Sheridan and Campbell Counties, Wyoming, should make this undeveloped coal region one of future economic importance. The physical and chemical properties of this coal are very similar to those of the Sheridan field, where considerable development has taken place.

RECREATION

The Big Horn National Forest has a variety of resources, including timber, water, forage and wildlife. In addition, it is a beautiful country of mountains, lakes, meadows and streams which lures tourists in ever increasing numbers. It provides many types of recreation, including camping, picnicking, fishing, hunting, winter sports and pack trips into the wilderness country. Thousands of visitors enjoy this vacation land each year. For the convenience of these people, six camp grounds and one picnic ground have been developed in the Powder River watershed. Six resorts and dude ranches operating on the forest under permit, furnish accomodations to the public and provide pack trips into the high country. Civic, fraternal and religious organizations have permanent camps and numerous summer homes and dude ranches are found adjacent to and within the forest. The town of Story, in Sheridan County, Wyoming, is becoming an increasingly popular summer resort in its natural mountain setting.

The Cloud Peak Wilderness Area is located in the most rugged portion of the forest and was set aside in 1932 to preserve unique natural values of wilderness and scenic charm for future generations to enjoy. The entire area lies at high elevations, ranging from 8,500 to 13,165 feet and includes approximately 50,000 acres of the Powder River watershed. Uses are made of the area for recreation, livestock grazing, wildlife and water storage. Cabins and resourts are not permitted in this remote wilderness area, and trail systems and other facilities are held to a minimum.

"Hell's Half Acre", one of the outstanding examples of geologic erosion, is located adjacent to U. S. Highway No. 20, about forty miles west of Casper. This area of precipitious crags and needles was once feared by the Indians as boding ill omens and bad luck. Thousands of tourists traveling to and from Yellowstone National Park photograph and view this sight of nature. Title to the area was conveyed from the U. S. Government to Natrona County in 1924 for park purposes.

FISH AND WILDLIFE

The many tributaries of the upper reaches of Powder River are supplied with clear cold water rising from the melting of snow in the humid mountain areas. It has been estimated that there are more than 500 miles of well-stocked trout streams in the Big Horn Range. These streams carry little or no silt or mud, and thus provide an ideal environment for trout. Upon reaching the lower semi-arid plains area, the streams become suitable for

only coarse fish such as suckers, because of silt-laden waters. The creation of numerous additional storage reservoirs, which reduce floods and collect silt, will aid in the clarification of waters and improvement of the fish habitat.

A fish hatchery located at Story, Sheridan County, Wyoming, is operated by the Wyoming Fish and Game Commission.

Hunting is an important sport throughout the basin. In Wyoming, for the year 1946, the big-game kill, within the basin, exceeded 3,500 animals, 1,600 antelope, 1,600 mule deer and 395 elk. According to official records of the Wyoming Fish and Game Commission for the year 1946, 6,000 hunters were attracted to the Big Horn area, 2,600 of whom were non-residents. Total license fees paid in 1946 were in excess of $100,000, one-sixth of that for the entire state. Non-residents alone spent an estimated $20,000 during the 1946 hunting season in Powder River basin.

Powder River basin constitutes a favorable habitat for numerous and varied wildlife groups. In the high mountain country within the humid coniferous forests are found bear, deer, elk, moose, beaver and numerous other small game, and an abundance of mountain inhabiting birds. Migratory water fowl and shore birds visit the mountain lakes in large numbers during seasonal migration and breeding periods. In the woodland areas bordering the mountains and in northern Campbell and Sheridan Counties, are found deer and American prong-horn antelope. The extensive areas of grasslands and sagebrush are inhabited principally by antelope.

In Montana, the heaviest concentrations of antelope are found east of Powder River in Powder River County and Carter County, although they are distributed quite generally throughout the entire Powder River Basin. The estimated antelope population in Montana is 3,000. In Wyoming, an estimated 5,000 antelope range in the plains areas along Powder River. In general, it may be said that the antelope range is coextensive with areas where public domain is most prevalent.

White-tailed deer are found only in a limited area in the Mizpah Creek drainage in Montana. The mule deer range is confined for the most part to southern Powder River County and the major part of Custer County, Montana, where there are an estimated 3,200 animals. In Wyoming, the Big Horn Range and Powder River breaks provide an ideal habitat for an estimated 8,000 mule deer.

The higher elevations of the Big Horn River support an estimated 1,200 elk. An estimated one-tenth of the total annual Wyoming state elk kill is made on the Big Horn National Forest.

Sharp-tailed grouse, often erroneously called prairie chicken or pintail grouse, have increased greatly and are now relatively abundant throughout Powder River County. This county is an ideal habitat because the area is remote from settled areas. The most abundant populations occur where only small areas are dry farmed, the remainder supporting native vegetation of grassland and more or less extensive areas of shrub cover such as sage.

Sage grouse or sage hen are likewise relatively abundant in Powder River, Custer and Carter Counties, Montana, and in Campbell County, Wyoming. They are most commonly observed in abandoned fields where stubble and weeds are most common, and are not necessarily confined to areas dominated by sage. Their range is much more closely restricted to the proximity of water than is the sharp-tail.

Hungarian partridge, while not abundant, are peculiarly adapted to intensively cultivated wheat-growing areas such as Ash Creek, Coalwood-Mizpah and Chalk Buttes areas.

The relatively few Chinese pheasants are confined principally to the bottomlands of Powder River and Little Powder in Montana and in Clear Creek and Crazy Woman Creek in Wyoming.

LAND MANAGEMENT PROGRAMS

Powder River basin presents a picture of diverse land management programs. Parts of six organized soil conservation districts lie within the basin, four of which are located in Wyoming and two in Montana, and comprise a gross area of approximately 950,000 acres, or about 11 percent of the entire basin. These soil conservation districts offer farmers and ranchers an effective means of self-help in meeting conservation problems. Through cooperative agreements with the Soil Conservation Service and other agencies, united group action and organization assures more efficient and more productive use of the land and water resources. The importance of the development of complete farm and ranch plans is stressed. The best use of the range and pasture lands is planned as an integral part of the entire operating unit, which includes crop and haylands. The extension of the district programs to reach a greater number of operators is desirable.

The Big Horn National Forest in Wyoming and two divisions of the Custer National Forest in Montana are partially within the Powder River watershed. They comprise an area of approximately 283,000 acres, equivalent to about four percent of the entire basin. About 50,000 acres of this area are included in the Cloud Peak Wilderness Area of the Big Horn National Forest.

The Naval Petroleum Reserve No. 3, more commonly known as "Teapot Dome" is administered by the Navy Department. Located in Natrona County, Wyoming, this reserve embraces a total area of 9,320 acres, the exterior boundary of which is completely fenced. Production of oil and gas in this reserve was discontinued in 1927. Four livestock operators have permits for winter grazing in this area which is administered locally by the Navy Department.

A very small portion of Tensleep Grazing District No. 1, in Washakie County, Wyoming, is included in the Powder River basin. The gross area consists of 2,480 acres, only 130 acres of which are public domain. This area is used for summer range.

With the exception of the two divisions of the Custer National Forest in Powder River County and Carter County, all of the Powder River watershed

in Montana is within Montana Grazing District No. 3. The gross area comprises 2,543,600 acres, of which 471,718 acres are public domain and 40 acres are withdrawn for Public Water Reserve.

The agricultural and conservation program of the Production and Marketing Administration, commonly known as the A.A.A. program, has met with widespread approval and participation by the farmers and ranchers within all counties in the basin. All soil conservation practices are designed to prevent erosion and are all based on the premise that grass is the best conserver of the soil. The provisions of the program are developed and administered through County and community committeemen elected by the local ranchers and farmers. Range practices completed since the inception of the program have been largely those tending toward better distribution of livestock and more uniform utilization of the range. On the basis of annual reports of the P.M.A., it is estimated that approximately 7,000 range livestock water reservoirs have been constructed, 900 springs have been developed, and about 700 wells have been drilled in the basin. Many ranches are still engaged in developing additional water supplies under this program.

Spring Creek Land Utilization Project Area

A relatively new part of the public land picture in the basin arises from land purchased by the Federal government. The Spring Creek Land Utilization Project Area in northeastern Campbell County is part of several similar enterprises in which the Soil Conservation Service is cooperating with Federal, State and local agencies and ranchers. Under Title III of the Bankhead-Jones Farm Tenant Act of July 22, 1937, the Secretary of Agriculture is authorized and directed "To develop a program of land conservation and land utilization, including the retirement of lands which are submarginal or not primarily suitable for cultivation, in order thereby to correct maladjustments in land use, and thus assist in controlling soil erosion, reforestation, preserving natural resources, mitigating floods, and to effectuate the program he is authorized to acquire by purchase, gift or devise, or by transfer from any agency of the United States, submarginal land and land not primarily suitable for cultivation, to protect, improve, develop and administer any property so acquired".

The Spring Creek Purchase Area comprises an area of approximately 100,000 acres, the greatest portion of which lies in the Little Powder River drainage. The remainder is located in the Little Missouri River basin to the east.

The lands acquired by Government purchase were formerly small dry land farms, abandoned homesteads and tracts of range located at strategic points for water development. The total cost of all land purchased amounted to $111,000, each tract having been appraised to determine its fair value. All the lands that were purchased were voluntarily offered for sale by the owners.

The Government bout out 27 of the 54 operators of the area. For the operators who remained in the area, there was then enough land to permit each to obtain a more economical unit. The average size of operating units in the area was increased from 1,700 acres to 4,760 acres. Land owned by the United States is now leased to individual operators through the Spring Creek Cooperative Livestock Association, formed in 1936 and consisting of 22 members. Either directly, or through its members, the Association controls all lands in the

area. The fees charged the Association by the Government for use of the land for each current year are based on the prevailing prices of livestock and livestock products and on the grazing capacity and general condition of the range. The Association enforces grazing permit regulations, prevents trespass, maintains range developments such as stock water reservoirs, springs and fences, and generally supervises the range operations of its members. Previously subject to many abuses associated with absentee ownership, land misuse, short-term leases and inadequate operating units, the area now provides a far greater stability to the present operators, due to a more satisfactory pattern of land use.

The classes of land ownership for the area within Powder River basin are as follows:

Public Domain Land	2,320 acres	2 percent
Title III Purchased Land	37,420 acres	48 percent
State Land	3,672 acres	5 percent
Privately Owned Land	35,088 acres	45 percent
Total Area	78,500 acres	100 percent

East Custer Cooperative State Grazing District

Incorporated under the laws of the State of Montana, the East Custer Cooperative State Grazing District entered into a 10-year cooperative agreement with the Bureau of Land Management in 1942 for the purpose of bringing about a better coordination of the use of all classes of land used for grazing within the district boundary. By virtue of this agreement, the Bureau of Land Management issues to the State district an annual license or term permit for the grazing privilege that may be utilized on the Federal range in the district by its licensees or permittees and, subject to review, permits the State District to refuse to issue grazing licenses or permits to applicants who fail or refuse to pay grazing fees or assessments due or who fail or refuse to abide by rules and regulations of the State District. The State Grazing District lies in east Custer County and within Montana Grazing District No. 3, established under the Taylor Grazing Act. It comprises a gross area of approximately 175,000 acres, about 80 percent of which lies in Powder River basin. The district includes 36,000 acres of submarginal lands which were purchased by the United States following the drought years of the thirties. Public domain comprises about 8,500 acres, and state, county, railroad and private lands make up the remainder, or about 75 percent of the total area. Under the cooperative agreement, the public domain is rated as having an average carrying capacity of 4.15 surface acres per animal unit month, while Government purchased lands are rated at 3.02 acres per animal unit month. A grazing permit is issued to each livestock operator, which specifies conditions under which the range is to be used and the number of livestock the user is entitled to run. Each member is charged a fee based upon the number of livestock grazed on the district lands.

Prairie County Cooperative State Grazing District

The Prairie County Cooperative State Grazing District is similar in authorization, purpose, function and operation to the East Custer Cooperative State Grazing District. Only a small portion of this State Grazing District is contained in the Powder River watershed. The gross area within the basin comprises 65,261 acres, or about four percent of the district. Classes of land ownership, acreage, and average carrying capacity are as follows:

Public Domain Land	5,471 acres	5.71 acres per animal unit month
Title III Purchased Land (Administered by the Soil Conservation Service)	17,881 acres	3.71 acres per animal unit month
State Land	3,590 acres	3.51 acres per animal unit month
Private Land	15,127 acres	- - -
Railroad Land	22,884 acres	3.65 acres per animal unit month
Indian Allotment Land	308 acres	- - -
Total Acres	65,261 acres	

Mizpah Pumpkin Creek Grazing District

The Mizpah Pumpkin Creek Grazing District, located partly in the Powder River basin in Custer County, Montana, is unique in that it was not only the first cooperative grazing district formed in the United States, but it was also the first one authorized by special Act of Congress. The preamble to the bill which made possible this area states that it is an Act authorizing the Secretary of the Interior to enter into a cooperative agreement or agreements with the State of Montana and private owners of land within the State of Montana for grazing and range development, and for other purposes. The Mizpah Pumpkin Creek Grazing Association was organized under state law in 1928, and comprised about 15 members who lived in or adjacent to the district. About 43 percent (46,000 acres) of the district lies in the portion of the Powder River watershed drained by Mizpah Creek. About 13,000 acres are public domain, 2,000 acres are owned by the Northern Pacific Railway Company, 2,500 acres belong to the State of Montana, and 28,500 acres are privately owned.

PROBLEMS RELATING TO THE PUBLIC DOMAIN

A reconnaissance survey and a cursory analysis of published reports and public records has revealed many problems relating to the management, protection, development and utilization of the public domain lands and their resources under the comprehensive program for the development and utilization of the resources in the Missouri River Basin. These studies have not been of sufficient detail to determine their scope and seriousness, nor to prescribe detailed corrective measures. Further investigations will be necessary and, no doubt, additional problems to those listed below will be discovered in the more detailed studies. As previously stated, the purpose of this preliminary survey and report is to determine and describe in general terms the role of the public lands in the development program and to point up the principal problems confronting the Bureau of Land Management in providing for the maximum contribution and service of this public land to the comprehensive program. The following problems appear pertinent at this time.

Problem A: Watershed breakdown and consequent siltation of stream courses and impoundments.

This probably is the biggest single problem pertaining to the public domain lands in the Powder River basin. This problem is not, however, peculiar to the public domain land only, but no doubt is more critical there than elsewhere, due to their poorer soil, vegetative cover and topographic characteristics. As previously explained, the public domain now occupies the lands of lowest productivity with respect to surficial resources. They are inherently the greatest contributors per unit area to siltation from geologic erosion. Many years of unregulated use prior to 1934 has no doubt contributed to the deterioration and depletion of the vegetative cover which has in turn resulted in the acceleration of the erosional processes.

Reconnaissance examination of the drainage area tributary to the Moorhead reservoir site indicates that large quantities of silt are carried by Powder River in the wake of each heavy storm as well as during the period of heavy spring run-off. A large part of the silt-load is probably a result of bank sloughing along the stream channels during such high-water flows. However, the more insidious though less spectacular form of silt contribution results from sheet erosion on disturbed and unstable soils which lack an adequate vegetative cover for their protection. Excessive run-off, while influenced by intensity and duration of rainfall and other factors, is greatly affected by the amount of vegetation. Soil losses and accelerated erosion are greatest in the extensive areas of heavy shales. Salt Creek and the South Fork and Middle Fork of Powder River are considered to be the major sediment contributors per unit drainage area, but available data are inconclusive and do not permit the reliable determination of the amounts of sediment produced by these major tributaries and their numerous ephemeral water courses. Until sufficient reliable data are made available to

determine the true origin and volume of the sediments produced in Powder River basin above the proposed Moorhead reservoir, a wholly reliable and comprehensive plan to obtain the optimum of soil erosion and sediment control cannot be presented.

The only sediment sampling station which exists at the present time on Powder River is at Arvada, Wyoming in southeast Sheridan County. The Water Resources Branch of the U. S. Geological Survey established this station in April 1946, and has been operating since. Records to date are inconclusive as to average condition; however, trends are indicated. For the period April 4, 1946 to September 30, 1947, the total discharge of silt from the 6,050 square mile drainage area above the station was over 9 million tons. Discharges were greatest during May and June, with over one and a half million tons per month and accounting for more than half of the total annual discharge. Discharges were least during the fall and winter months.

In order to establish adequate basic sedimentation data as to amounts, origin and movement of silt, it is believed that additional stations should be installed at or near the mouths of major silt contributing tributaries or at existing stream gauging stations in Powder River basin. In the drainage basins of South Fork and Salt Creek, where the bulk of public lands are situated, the amounts, origin and movements of sediment should be determined in order to facilitate a comprehensive program of public land rehabilitation, development and proper utilization. The installation of coordinated erosion measurement and vegetation plots in representative areas of high silt production and in areas where public lands are predominant will also go far in providing much needed erosion and sedimentation data.

The solution of the silt problem is dependent upon two physical accomplishments. First, where ever possible, soil must be held in place. The maintenance of an adequate vegetative cover is the only practicable means by which this can be accomplished over large areas. Second, where topography, geology, soils, climate and other natural conditions preclude the maintenance of an adequate vegetative cover, that is where normal or geologic erosion results in any considerable movement of soil, the resulting silt must be trapped, if reasonably possible, before it reaches the main channels. The sagebrush type, occupying areas of characteristically heavy soils, is probably the heaviest silt producer in Powder River basin. Accelerated erosion continues to be active in very rough parts of the watershed occupied by this type of vegetation. In the vicinity of the heavily overgrazed stock driveways, deep-cut gullies are frequent, and areas surrounding stock water facilities are too often in a very deteriorated condition. In the grass-land type, on the other hand, there is very little evidence of accelerated erosion except in localized areas.

With the exception of sediment records for Powder River at Arvada, Wyoming, no actual records are available to determine the

relative silt contributions from the principal tributary streams above Moorhead reservoir site. Such data are needed as a guide to future action. However, on the basis of existing information obtained from various local sources, it is believed to be the consensus that the greatest silt contributions are derived principally from: (1) the upland plains watersheds of South and Middle Forks of Powder River; (2) Salt Creek; (3) the locally dissected "badlands" bordering the main stem of Powder River north of Sussex, and (4) possibly to a lesser extent, Wild Horse Creek near Arvada. This comprises an area of about 5,000 square miles. Portions of the lower elevations of North Fork of Powder River watershed may also have some influence upon silt production. Clear Creek and Crazy Woman Creek appear to be of comparatively little significance insofar as silt contribution is concerned, although it is interesting to note that these two streams are the principal sustaining water carriers in the basin.

The probability that the above-named streams are the source of major portions of silt derived from the basin is of great concern to the Bureau of Land Management because the amounts of public domain in these areas are relatively high. Public lands constitute about 30 to 35 percent of all classes of land ownership in these areas of high silt production.

A detailed survey of the soil erosion situation and vegetative cover of the public domain land and a determination of feasible corrections or control measures is necessary. This should also be accomplished for lands under other classes of ownership, particularly state and private, as the problem must be tackled on a watershed basis.

Problem B: Maladjustments in public land use.

As most of the land in the basin is range land, range management has a most important bearing on the economy of the area. A reconnaissance survey reveals that much range depletion and deterioriation has taken place during the past. Many of the more desirable range plants are being or have been replaced locally by inferior specie. The grazing capacity has consequently diminished. Arrested depletion and sustained yield of the forage resources can be attained only if the range is properly stocked. Attempts to restore the range resource through changes in seasonal use and methods of handling, fencing, reseeding, water developments and other devices will fail unless the intensity of grazing use is brought within the safe long-time grazing capacity limits of the range lands.

coin of the realm?

In establishing a livestock economy, the range users have made some adjustments in the utilization of the range resources, although the methods of adjustment in all instances do not yet measure up to a well established economy. This is perhaps best illustrated by the existing problems of seasonal misuse of forage resources.

Range rehabilitation through proper management has not kept pace with the improvements in grades of livestock, better husbandry methods, or increased marketing outlets. Forage removed in excessive amounts continues to contribute to the progressive destruction of the range resources, a practice which sooner or later will place such users at an economic disadvantage with more conservative range users. Improvements probably must involve modification of confirmed habits in livestock operations.

One of the most promising outlooks for obtaining proper range use in the basin is found in the growing realization on the part of stockmen that conservative stocking is to their own financial advantage, as well as to the social advantage of the community in protecting land resources.

The problem connected with public land administration also includes the provision for proper management facilities, such as fences, wells, stock water reservoirs, and such rehabilitation measures as flood irrigation, water spreading and range reseeding. Considering the magnitude and significance of the public domain with respect to the problem of siltation alone makes it imperative that a rehabilitation program in the most critical areas be started without delay.

The amount of range rehabilitation work that has been completed is insignificant in relation to the magnitude of the needs. Range developments and facilities which have heretofore been constructed on public lands have been mainly of the type which have facilitated livestock operations and livestock movement. A total of approximately 145 range development projects have been constructed on public lands in the Powder River basin by the Bureau of Land Management. The total expenditure for the construction and maintenance of these improvements was approximately $125,000, of which $27,000 was contributed by Wyoming livestock operators. Government expenditures in the Wyoming portion of the basin amounted to about $59,000 through fiscal year 1947, and about $39,000 was expended in Montana through the same period. In addition to these public land range improvement projects, ranchers have constructed under permit in Montana Grazing District No. 3 about 105 miles of fence, 21 stock water reservoirs, 3 wells and one shearing pen, at a total cost of about $22,000. No estimates are available with regard to the value of range improvements placed on public domain by lessees in the Wyoming portion of the basin, but it is believed to be a fairly substantial amount.

Problem C: Complex land ownership and operating patterns.

The public domain map (index) shows the scattered location and extent of the public domain land and the various Federal land management programs in operation in the Powder River basin. Federal land disposition and acquisition programs have both been operative within the past 15 years. A lack of sound policy as to Federal land

Range rehabilitation through proper management has not kept pace with the improvements in grades of livestock, better husbandry methods, or improved marketing outlets. Forage removal in excessive amounts continues to contribute to the progressive destruction of the range resources, a practice which sooner or later will place each owner at an economic disadvantage with more conservative range users. Improvements probably must involve adjustments within individual operations.

One of the most promising methods for obtaining proper range use on the basis is found in the grazing association or district of [illegible] that cooperatively, according to their own financial advantage as well as to the social advantage of the community in protecting land resources.

The problem connected with public land administration that includes planning and providing for proper management of the use of forage, soils, stock-water reservoirs, and such [illegible] facilities as flood irrigation, water spreading and range facilities. Considering the magnitude and significance of the public domain with respect to the problem of siltation alone makes it imperative that a rehabilitation program in the most critical areas be started without delay.

The amount of range rehabilitation work that has been completed is insignificant in relation to the magnitude of the problem. Range development and facilities which have been installed by conservation on public lands have been mainly of the type which have facilitated livestock operations and livestock movements. A total of approximately 160 range development projects have been constructed on public lands in the Powder River Basin by the Bureau of Land Management. The total expenditure for the construction and maintenance of these improvements was approximately $118,000, of which $23,000 was contributed by Wyoming livestock operators. Government expenditures in the Wyoming portion of the basin amounted to about $98,000 through fiscal year 1947, and about $10,000 was expended in Montana through the same period. In addition to these public land range improvement projects, ranchers have constructed under permits in Montana Grazing District No. 3 about 172 miles of fence, 22 stock water reservoirs, 5 wells and one spreader dam, at a total cost of about $80,000. No estimation was available with respect to the value of range improvements placed on public lands by ranchers in the Wyoming portion of the basin, but it is believed to be a fairly substantial amount.

Problem of Federal land ownership and administrative practices

The public lands map (figure) shows the location and extent of the public domain land and the various Federal land management programs in operation in the Powder River Basin. Federal land disposition and acquisition policies have undergone a complete change within recent years. A lack of sound policy as to Federal land programs is complicating long-range planning for this as well as other areas in the Missouri Basin. Superficial analysis of the land capabilities and land use economics indicate that much of the "public domain", principally the isolated and widely scattered tracts, could be most effectively managed and utilized under private ownership. Further detailed study of each tract of public domain land and a comprehensive analysis of the entire land use economy of the area is necessary to develop a sound policy and approach to more effective land administration and resource utilization. The many and varied uses of lands and their relationship to public interests and public problems must be fully considered.

Problem D: Stock driveway situation.

A fourth problem so far encountered involves all of the three previously mentioned. It is the problem arising from and indigenous to the stock driveway situation in the upper portion of the Powder River basin. Concurrent with the passage of the stock raising homestead act of 1916, many public domain lands were withdrawn for the alleged purpose of stock driveways to provide access for movements of livestock from range and ranch to market and between-season range areas. Since 1916, the methods of livestock operations have changed and so has the land use economy in the area. Most of the stock driveway withdrawals remain intact, some are used in one way or another to excess, with the result that both the forage and soil resources have seriously deteriorated. It is believed that the resource condition on the stock driveways is more critical than on any other type of land in this area. This condition may be attributable in part to the fact that there has been no administrative authority charged with the responsibility of regulation, management and administration of stock driveway lands outside of Federal Grazing Districts.

There are five principal stock driveways or trail systems in the Powder River basin in Wyoming. These five trails include a total of some 123,000 acres of withdrawn public domain land. In addition, there are many small disconnected driveway withdrawals scattered throughout the upper portion of the basin which include about 20,000 additional acres of public land.

In cooperation with counties and livestock associations, stock driveway committees have been formed in each of Natrona and Johnson Counties. These committees have "assumed" the function of regulating the use of these driveways but, having no administrative authority nor no law with penalty provisions, they have been helpless in trying to eliminate or materially reduce the many abuses, such as trespass, that have been occurring.

In some cases, the driveways are inadequate to provide orderly and proper access between seasonal ranges and between

ranches and markets. On the other hand, many of the withdrawn lands are no longer needed and many, no doubt, were never needed for stock driveway purposes. It appears that many adjustments such as are possible through land exchange, could be worked out to relieve some of the driveway problems. Other problems concerning the stock driveway situation and requiring attention include:

1. The need for improvements and facilities such as stock water, fences and boundary markers, to promote orderly use.

2. The need for soil and water conservation measures to rehabilitate the deteriorated and depleted resources.

Further detailed study to develop factual data for the solution of these and other problems relating to the stock driveway situation is urgently needed.

Problem E: Integration of land uses.

This problem also is overlapping in scope. It must be considered in connection with all of the others.

As explained earlier in this report, the predominant land use economy in the Powder River basin is built around the range livestock industry. The development of additional forage crop producing farm land through irrigation will no doubt increase the demand for range land use. Through effective integration of such crop land use with range land use, many of the present hazards to the year-round grazing operation could be alleviated, and many of the improper seasonal use grazing practices could be eliminated.

According to statistics of the Production and Marketing Administration, during the past few years the greatest part of the crop land is used for the production of hay, and on many ranches no other crop is grown. Hay was produced on over 156,000 acres, or on 61 percent of the crop land. Small grains were harvested on approximately 66,000 acres, or 26 percent of the crop land. Other miscellaneous crops were produced on about 11,000 acres, or 4 percent. Idle, fallow or pastured crop land comprised almost 18,000 acres, or 7 percent, while slightly less than one percent of planted crop land was reported crop failure.

About 68 percent of the total forage required for livestock is produced on native range lands, while forage production on hay lands furnishes slightly more than 23 percent of the required feed. Small grains, while principally a cash crop, furnish 5 percent of feed. Thus, for the area as a whole, it may be said that about 96 percent of the required forage is produced in the basin, while the remaining four percent of the required feed is brought in from other areas, the greater part in the form of concentrates.

An analysis of the feed production and requirements, when broken down by states, however, reveals a considerably different condition than that for the basin as a whole. In Montana, for instance, under present practices a slight surplus of feed over requirements is revealed, despite the fact that over 80 percent of the required feed comes from range lands. Numerous stacks of hay are held in reserve, many of which are carried over a period of several years as insurance against less bountiful future days or for anticipated emergency feeding periods. The feed situation in the Montana portion of the basin, therefore, is a healthy one, one in which the livestock operators are in a better position to cope with acute adverse conditions than they have been in the past. The dependency of the livestock operators upon range resources for the bulk of their feed should nevertheless be borne in mind. One or a series of unfavorable years in range resource conditions can again cause considerable distress in livestock practice. The expansion of additional irrigation facilities such as are planned along Powder River will go far toward relieving this situation.

The need for such additional facilities becomes even more apparent in the Wyoming portion of the basin, where under present practices, a deficiency of 10 to 15 percent in feed requirements is indicated. Of the total estimated forage required in the Wyoming portion of the basin, about 65 percent is produced on range lands, about 20 percent on hay lands and 5 percent is obtained from feed grains, stubble and straw. The apparent deficiency of approximately 10 percent comprises purchased feeds, most of which is brought in in the form of feed concentrates.

The deficiency in feed requirements is generally greatest where dependency upon range resources is greatest, and a further corollary to this fact is that the deficiency apparently becomes most acute in areas where public lands make up significantly high percentages of all classes of land ownership. Furthermore, the deficiency appears to be greatest in areas where sheep production predominates and where seasonal migration is a common phase of livestock operation. Lack of spring-fall range and recurrent seasonal misuse is symptomatic of such deficient areas.

The almost complete dependency of some operators upon range forage in southern Johnson County and in Natrona County accentuates the need for supplemental and additional irrigation developments in this portion of the basin. A recurrence of the range conditions which prevailed during the drought of the 1930's will almost certainly result in greater distress among such operators than those more favorably situated near irrigation developments along Powder River and its tributaries.

The need for further studies of the public lands and their relationship to proposed irrigation developments is of particular

importance in the Wyoming portion of Powder River basin, because the future economy of much of the area hinges heavily upon the proper use of the public range lands.

With increased development will come increased population and increased demands for recreational uses including fishing, hunting, camping and just plain scenic driving. The public lands now contribute to all of these and other recreational uses. They will no doubt be called upon to contribute more. Hell's Half Acre in the upper portion of the basin and along U. S. Highway No. 20 attracts many tourists. This tract is uniquely situated and well-named, but there are many more acres in a "Holluva" shape that may be of interest at some future time. Incidentally, Hell's Half Acre (320 acres) was deeded to Natrona County by the U. S. Government for recreational uses in 1924. The county has given only token administration to the site.

Problem F: Rodent and insect infestation.

These problems are recurrent, and no doubt we will just have to learn to live with them. Rodent infestations can be and have been important contributing factors to forage depletion and resulting vegetation and soil deterioration. Effects are generally quite localized, and recent developments in control measures are proving very effective.

Grasshopper and cricket infestations remain a serious menace over broad areas. Control measures have so far been sadly inadequate. These are problems concerning the biologist and entomologist, and no doubt will be ably and promptly dealt with.

Problem G: Poison plant problems.

This is a minor problem in the Powder River basin according to reports studied and reconnaissance surveys made. It is also one which can ordinarily be solved through proper land use. It is not expected that much trouble in this connection will be encountered. The vegetation inventory will include the existence, abundance and location of poisonous plants.

Further land classification studies are necessary to obtain the basic data necessary to the solution of the problems here enumerated and to discover other problems not mentioned and plan for their solution. A remedial program should be preceeded by a detailed inventory and classification of the resources of the public domain lands, their capabilities, suitability and condition. A comprehensive analysis of the total land use economy of the basin should be made in cooperation with other land managing agencies and interests.

Such detailed studies should include a qualitative and quantitative appraisal of the many complex multiple land use relationships, with

emphasis on their watershed significance. With the development of large impoundments on the main tributaries and main stem of the Missouri River, the proper management and protection of the upper watershed area assumes greater importance.

Charged with the responsibility of properly administering and managing nearly one-fourth of the total land area in the Powder River basin, the Bureau of Land Management is directly concerned with the pervasive problem of achieving a balanced land use economy that recognizes all interests. Progress toward this objective will be conditioned in large measure by the extent to which complementary action is effected by the coordinated efforts of all interested agencies, organizations, groups and individuals.

Detailed studies necessary to the solution of these problems will be carried forward by the Bureau of Land Management in the following four sub-areas or problem areas in the order mentioned:

1. Upper Powder River, which will include the drainages of North, Middle and South Forks of Powder River and Salt Creek in Converse, Johnson, Natrona and Washakie Counties.

2. Powder River breaks, which will include the main stem of Powder River tributary to the proposed Moorhead reservoir, but will exclude Crazy Woman and Clear Creek drainages.

3. Moorhead-Powderville sub-area in Montana, which will include all of the watershed in Carter County and all of Powder River County except the Mizpah Creek watershed.

4. The remainder of the watershed or basin.

Sub-areas 1, 2 and 3 have been delineated principally on the basis of the amount and concentration of the public domain lands in the area. Sub-area 4 includes the portion of the basin which contains relatively little public domain, and what remains consists principally of small isolated parcels. Further study of these tracts is necessary to determine the management or disposition (from Federal ownership) which should be carried out.

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Approved:
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Date:

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DIVISION OF LAND PLANNING

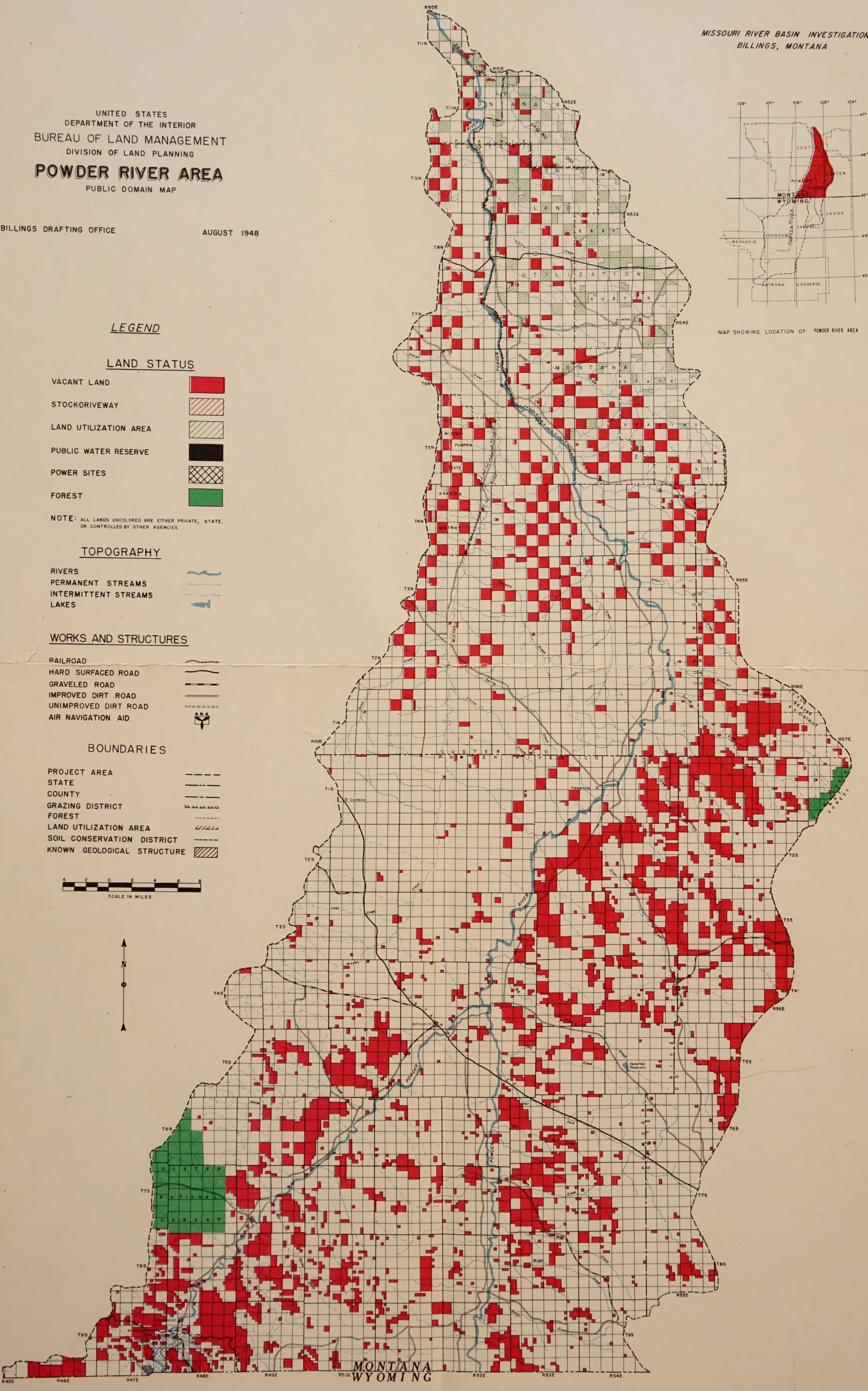
POWDER RIVER AREA

PUBLIC DOMAIN MAP

BILLINGS DRAFTING OFFICE

AUGUST 1948

MISSOURI RIVER BASIN INVESTIGATION
BILLINGS, MONTANA



MAP SHOWING LOCATION OF POWDER RIVER AREA

LEGEND

LAND STATUS

VACANT LAND 🟥
STOCK-DRIVEWAY ▨
LAND UTILIZATION AREA ▨
PUBLIC WATER RESERVE ■
POWER SITES ▦
FOREST 🟩

NOTE: ALL LANDS UNCOLORED ARE EITHER PRIVATE, STATE, OR CONTROLLED BY OTHER AGENCIES.

TOPOGRAPHY

RIVERS
PERMANENT STREAMS
INTERMITTENT STREAMS
LAKES

WORKS AND STRUCTURES

RAILROAD
HARD SURFACED ROAD
GRAVELED ROAD
IMPROVED DIRT ROAD
UNIMPROVED DIRT ROAD
AIR NAVIGATION AID A.N.A.

BOUNDARIES

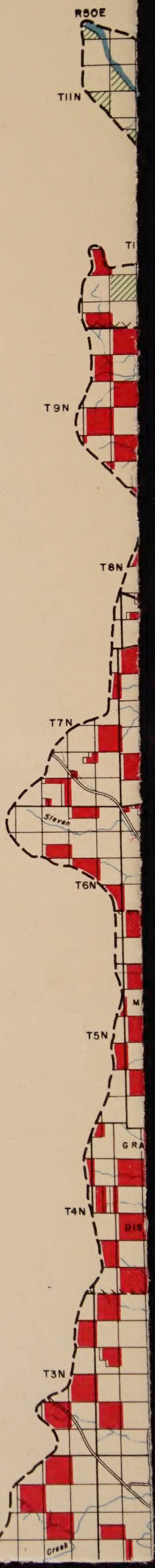
PROJECT AREA
STATE
COUNTY
GRAZING DISTRICT
FOREST
LAND UTILIZATION AREA
SOIL CONSERVATION DISTRICT
KNOWN GEOLOGICAL STRUCTURE ▨

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
DIVISION OF LAND PLANNING

POWDER RIVER AREA

PUBLIC DOMAIN MAP

BILLINGS DRAFTING OFFICE AUGUST 1948



LEGEND

LAND STATUS

VACANT LAND	🟥
STOCK-DRIVEWAY	▨
LAND UTILIZATION AREA	▨
PUBLIC WATER RESERVE	⬛
POWER SITES	▩
FOREST	🟩

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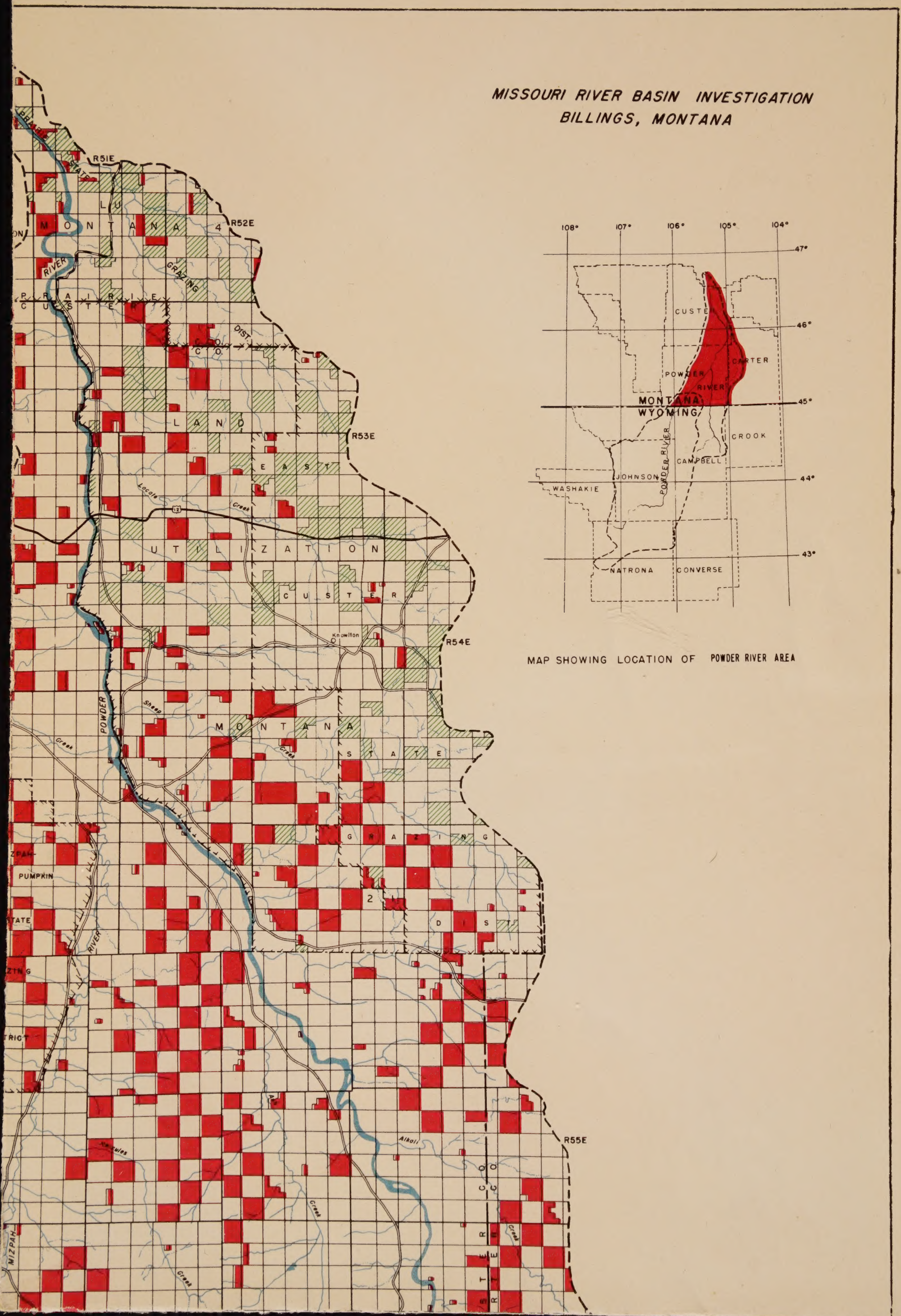
TOPOGRAPHY

RIVERS	〰
PERMANENT STREAMS	~
INTERMITTENT STREAMS	~
LAKES	●

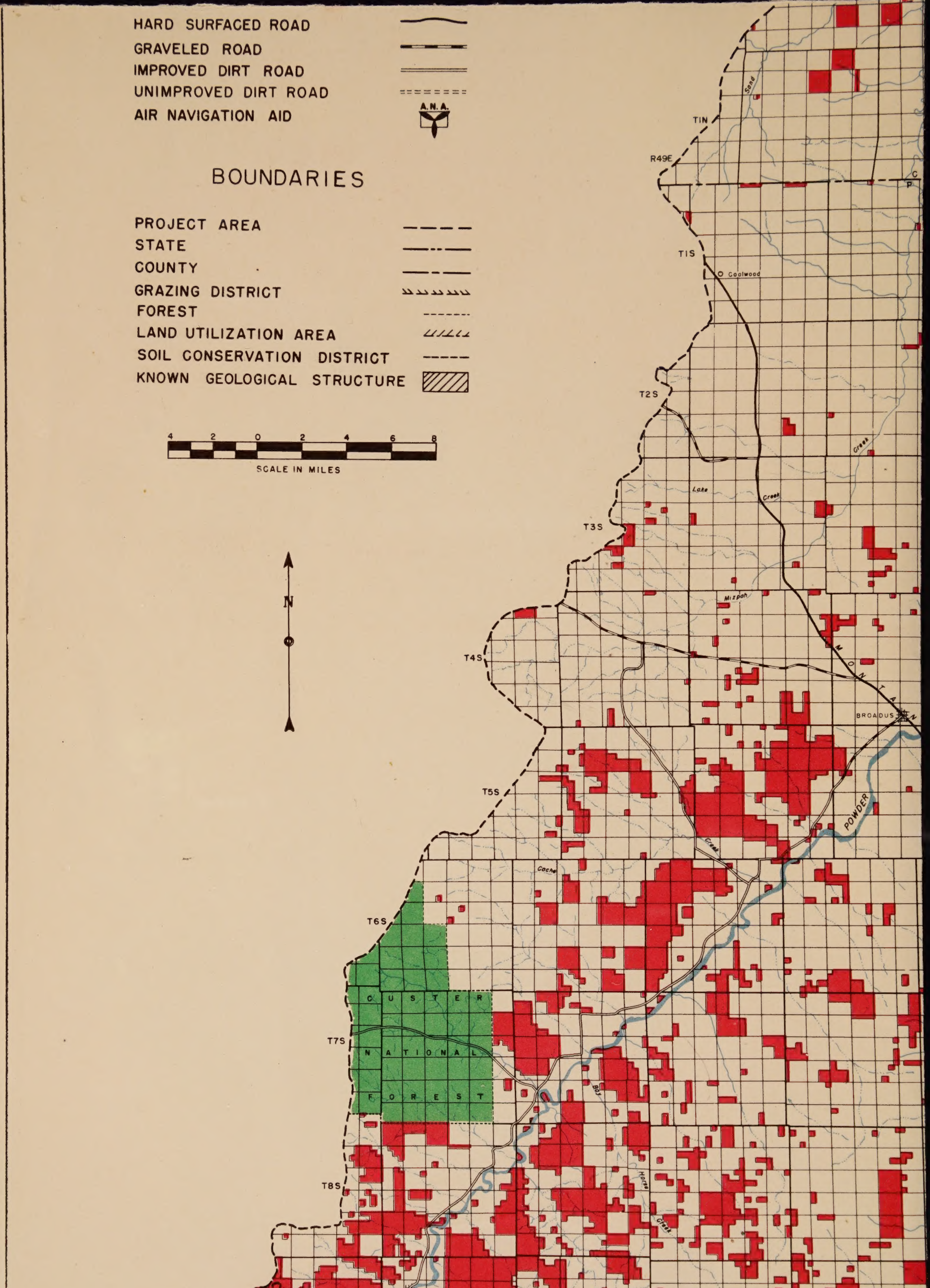
WORKS AND STRUCTURES

RAILROAD	┼┼┼



MISSOURI RIVER BASIN INVESTIGATION
BILLINGS, MONTANA

MAP SHOWING LOCATION OF POWDER RIVER AREA


HARD SURFACED ROAD
GRAVELED ROAD
IMPROVED DIRT ROAD
UNIMPROVED DIRT ROAD
AIR NAVIGATION AID
A.N.A.
BOUNDARIES
PROJECT AREA
STATE
COUNTY
GRAZING DISTRICT
FOREST
LAND UTILIZATION AREA
SOIL CONSERVATION DISTRICT
KNOWN GEOLOGICAL STRUCTURE
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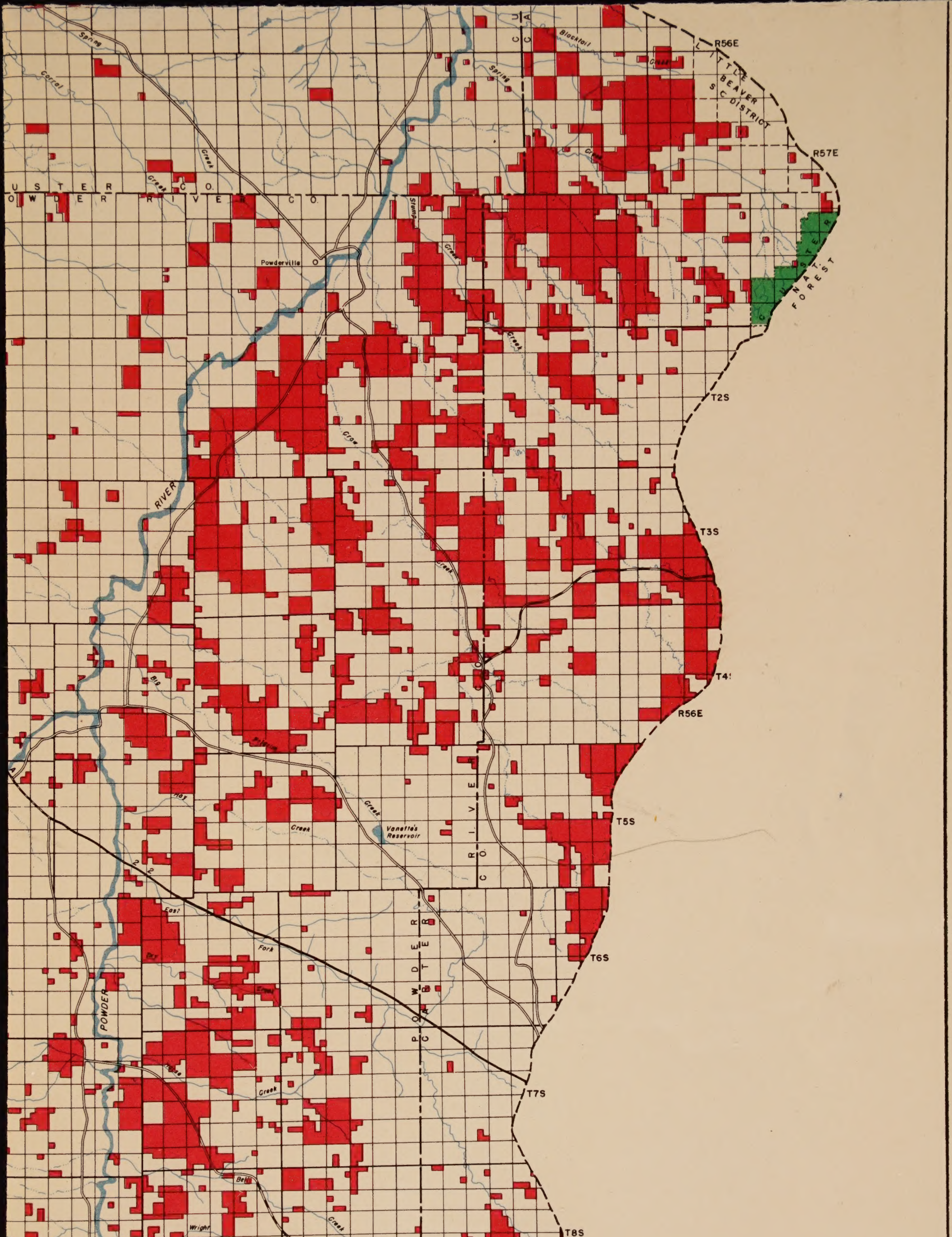
Lake
Creek
Mizpah
Creek
BROADUS
MONTANA
POWDER
Cache
Creek
CUSTER NATIONAL FOREST
Horse
Creek
MOORHEAD
MOORHEAD DAM SITE
R45E
R46E
R47E
R48E
R49E
R50E
MONTANA
WYOMING



Spring
Corral
Creek
Creek
USTER C O.
OWDER RIVER C O.
Blacktail
Spring
Creek
Creek
Creek
LITTLE BEAVER S.C. DISTRICT
CUSTER NAT. FOREST
R56E
R57E
CU CA
Powderville
Stump
Creek
Creek
Crow
Creek
RIVER
T2S
T3S
T4S
R56E
Big
Pilgrim
Hay
Creek
Creek
Vanetta's Reservoir
RIVER CO.
T5S
22
East
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Dry
Creek
POWDER
POWDER CARTER
T6S
Creek
T7S
Bell
Wright
Creek
Creek
T8S
R55E
LITTLE
Ranch
Creek
T9S
R52E
R53E
R54E

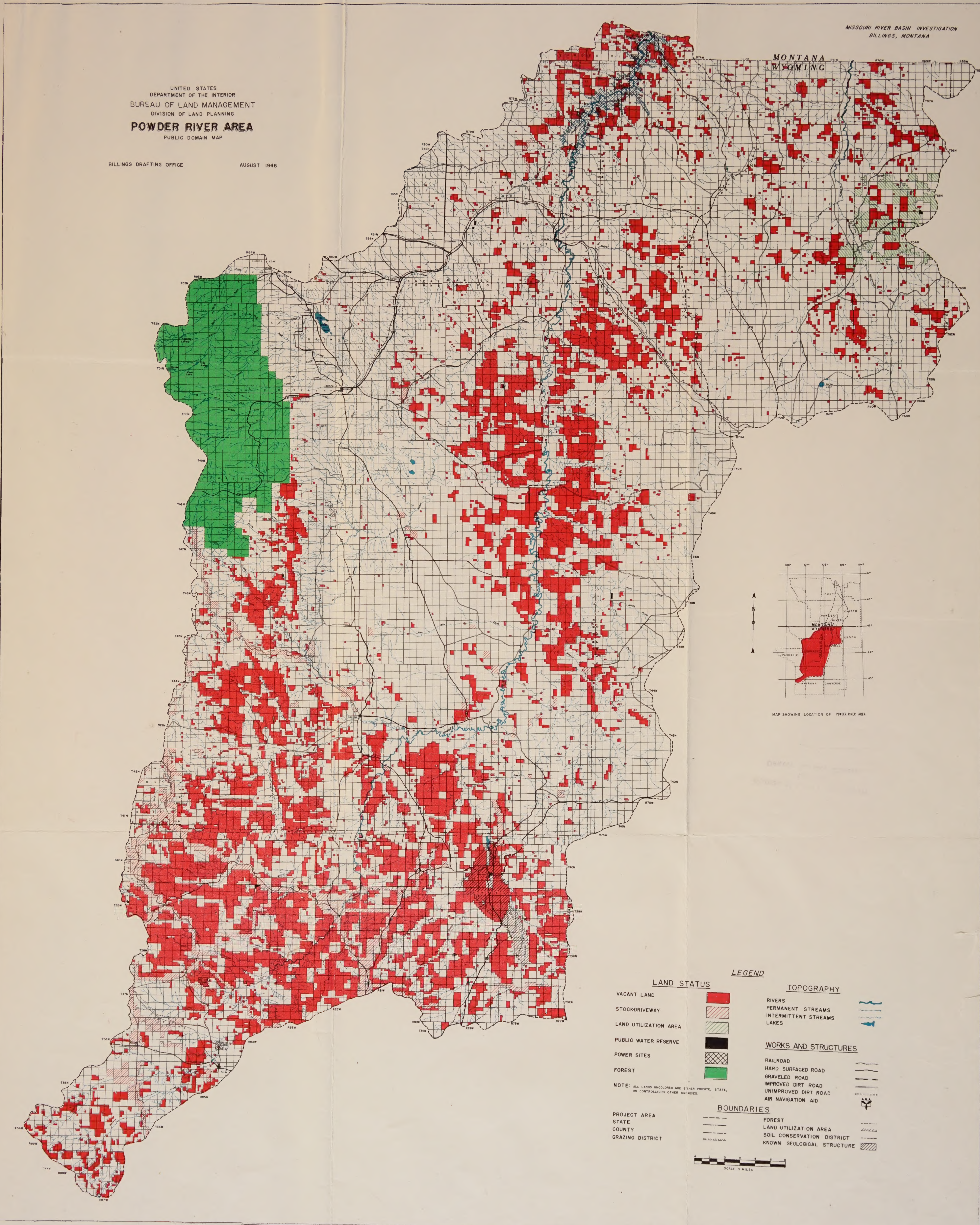
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
DIVISION OF LAND PLANNING

POWDER RIVER AREA

PUBLIC DOMAIN MAP

BILLINGS DRAFTING OFFICE AUGUST 1948

MISSOURI RIVER BASIN INVESTIGATION
BILLINGS, MONTANA



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DIVISION OF LAND PLANNING

POWDER RIVER AREA

PUBLIC DOMAIN MAP

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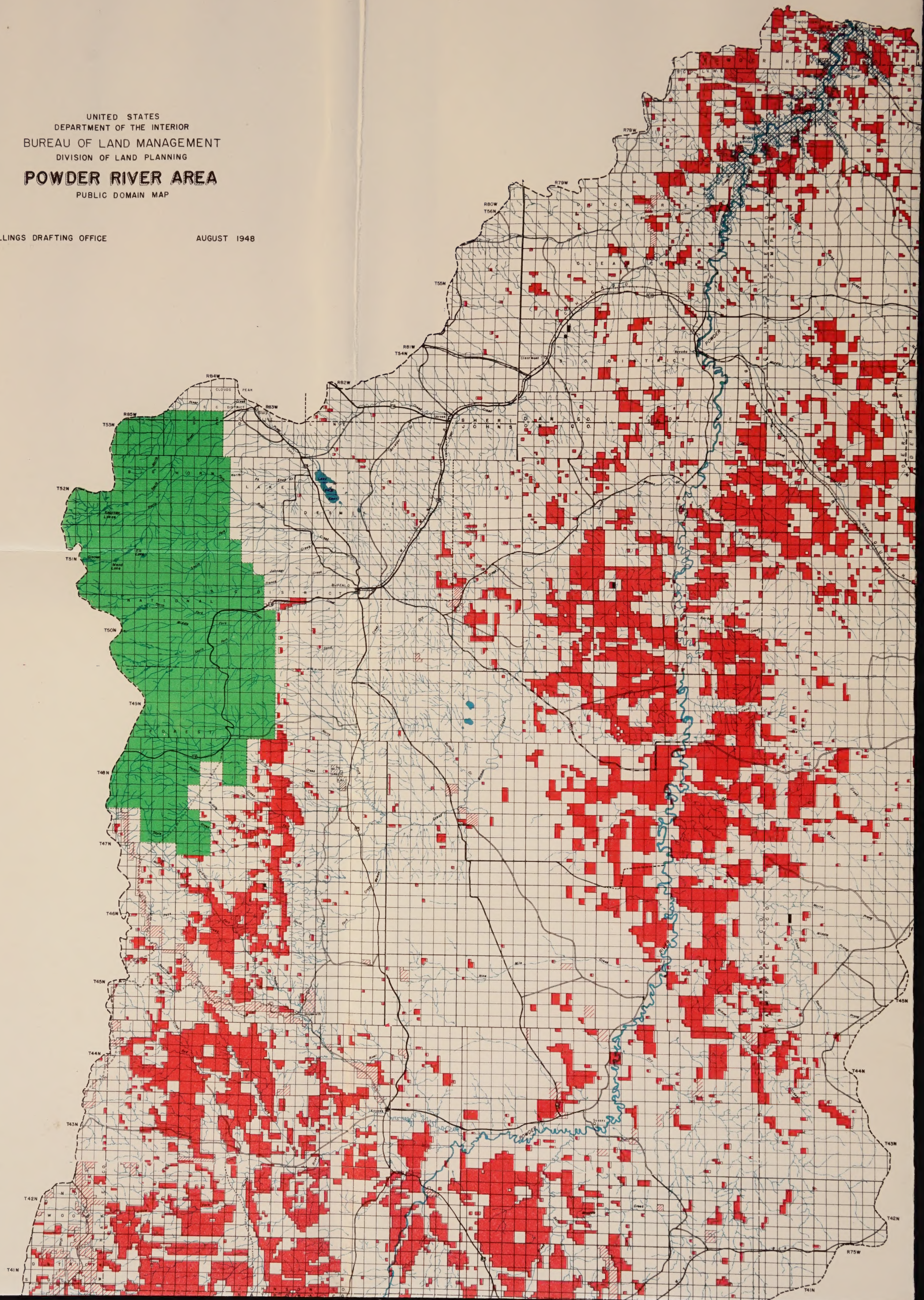
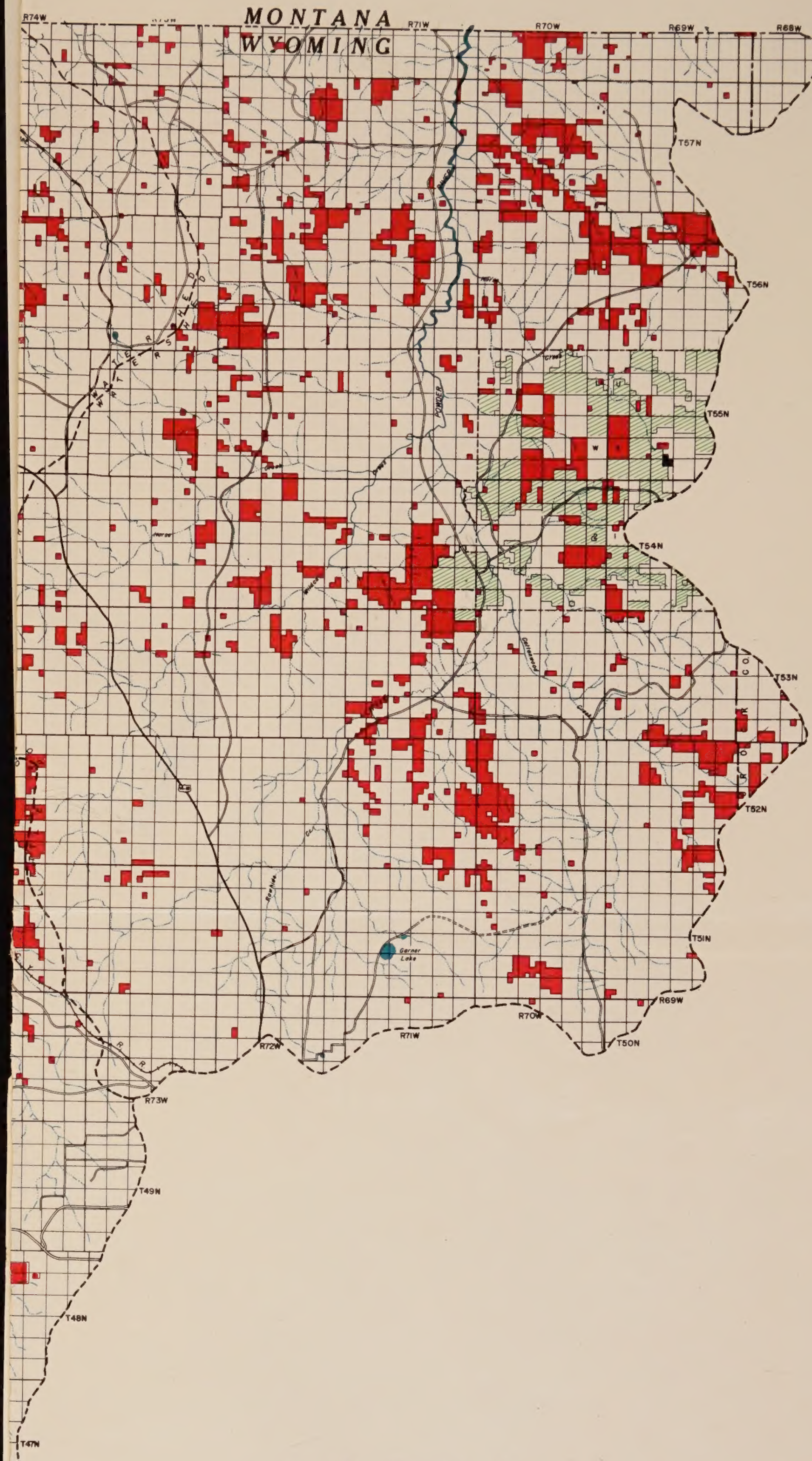
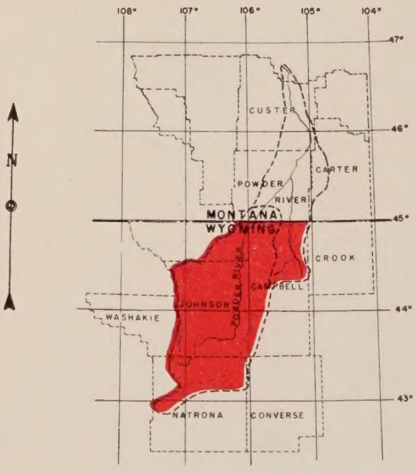
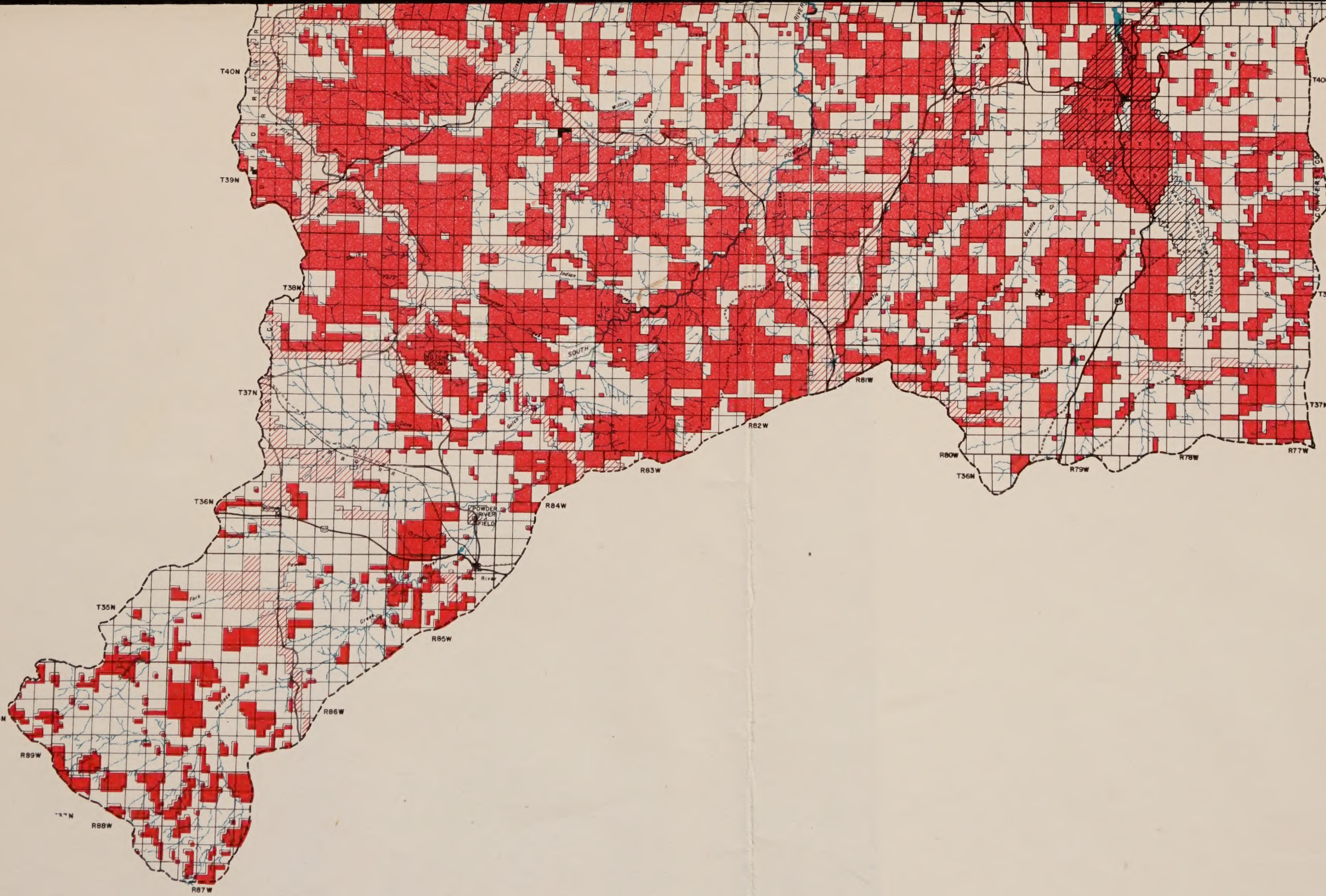


MISSOURI RIVER BASIN INVESTIGATION
BILLINGS, MONTANA





MAP SHOWING LOCATION OF POWDER RIVER AREA



LAND S

VACANT LAND

STOCK-DRIVEWAY

LAND UTILIZATION AREA

PUBLIC WATER RESERVE

POWER SITES

FOREST

NOTE: ALL LANDS UNCOLORED ARE E
OR CONTROLLED BY OTHER AG

PROJECT AREA
STATE
COUNTY
GRAZING DISTRICT

LEGEND

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TOPOGRAPHY

RIVERS	〰
PERMANENT STREAMS	∼
INTERMITTENT STREAMS	-∼-
LAKES	▬

WORKS AND STRUCTURES

RAILROAD	┼┼┼┼
HARD SURFACED ROAD	——
GRAVELED ROAD	━ ━ ━
IMPROVED DIRT ROAD	═══
UNIMPROVED DIRT ROAD	=======
AIR NAVIGATION AID	A.N.A.

BOUNDARIES

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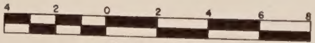
FOREST	-------
LAND UTILIZATION AREA	⊿⊿⊿⊿
SOIL CONSERVATION DISTRICT	-----
KNOWN GEOLOGICAL STRUCTURE	▨



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